

Antarctic MELTDOWN?

**Exclusive
Photos:
Stealth
Humvee**

Controversial New
Evidence for a
Changing Climate

**Cable TV
BATTLES
Dish TV**

A TIMES MIRROR MAGAZINE
www.popsci.com



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125
YEARS
OF POPULAR SCIENCE

This Month:

Our Quest to Conquer the Heavens





*Based on an average of consumer-reported problems at 3-months' ownership in a survey of Ford and competitive models designed and built in North America. Sales leadership based on Divisional sales.

www.ford.com



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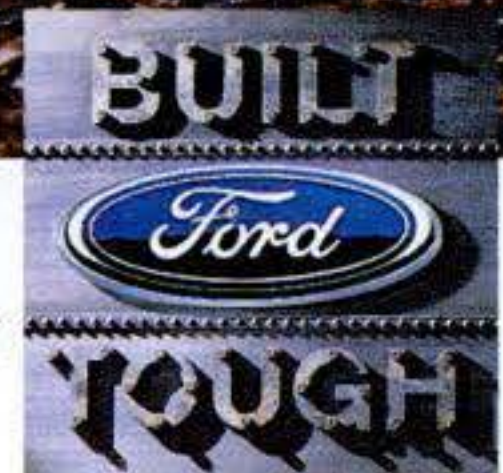
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This One



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The TV you own when you can own any TV.

Trinitron

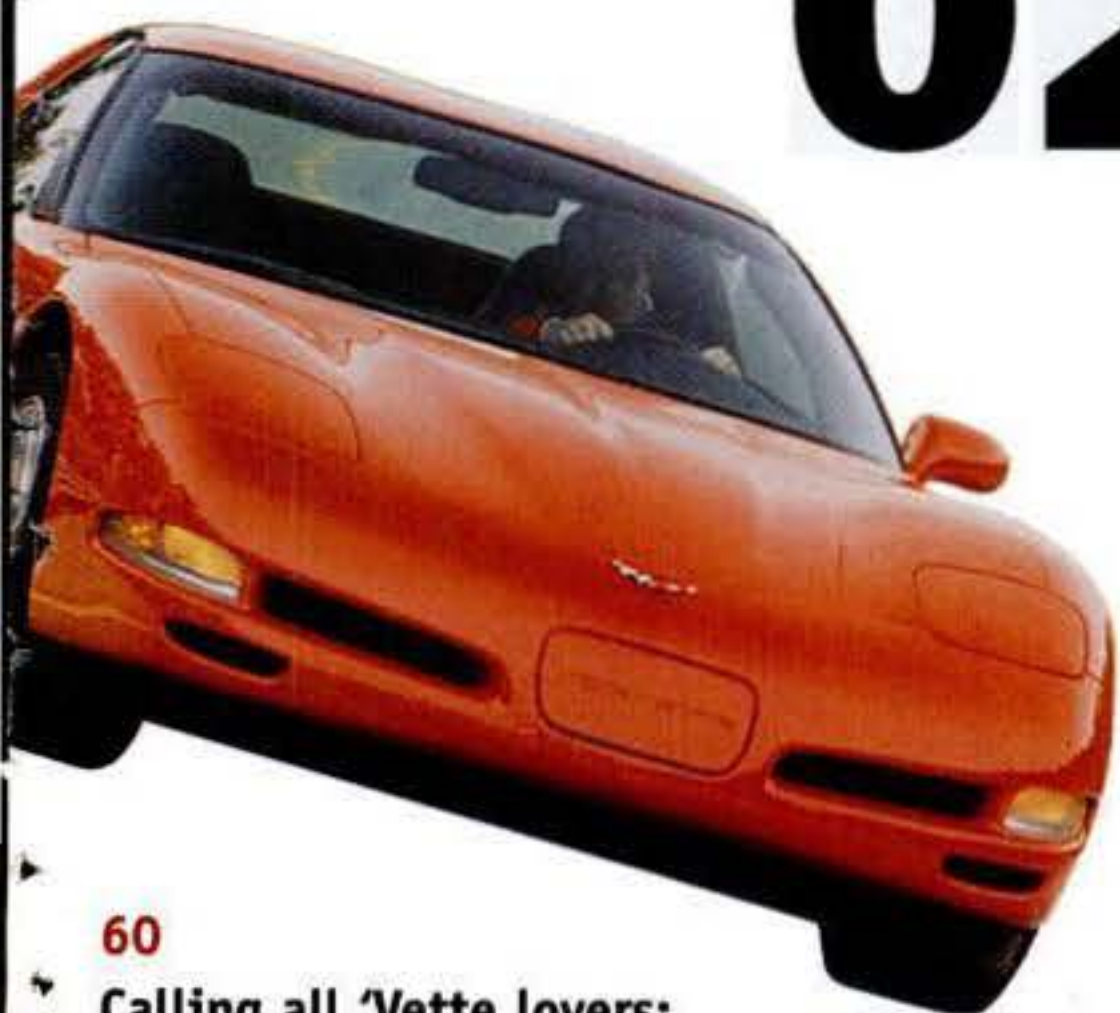
Forgive us for sounding
immodest, but this is, after all,
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the other way around?

SONY



02 PS 97

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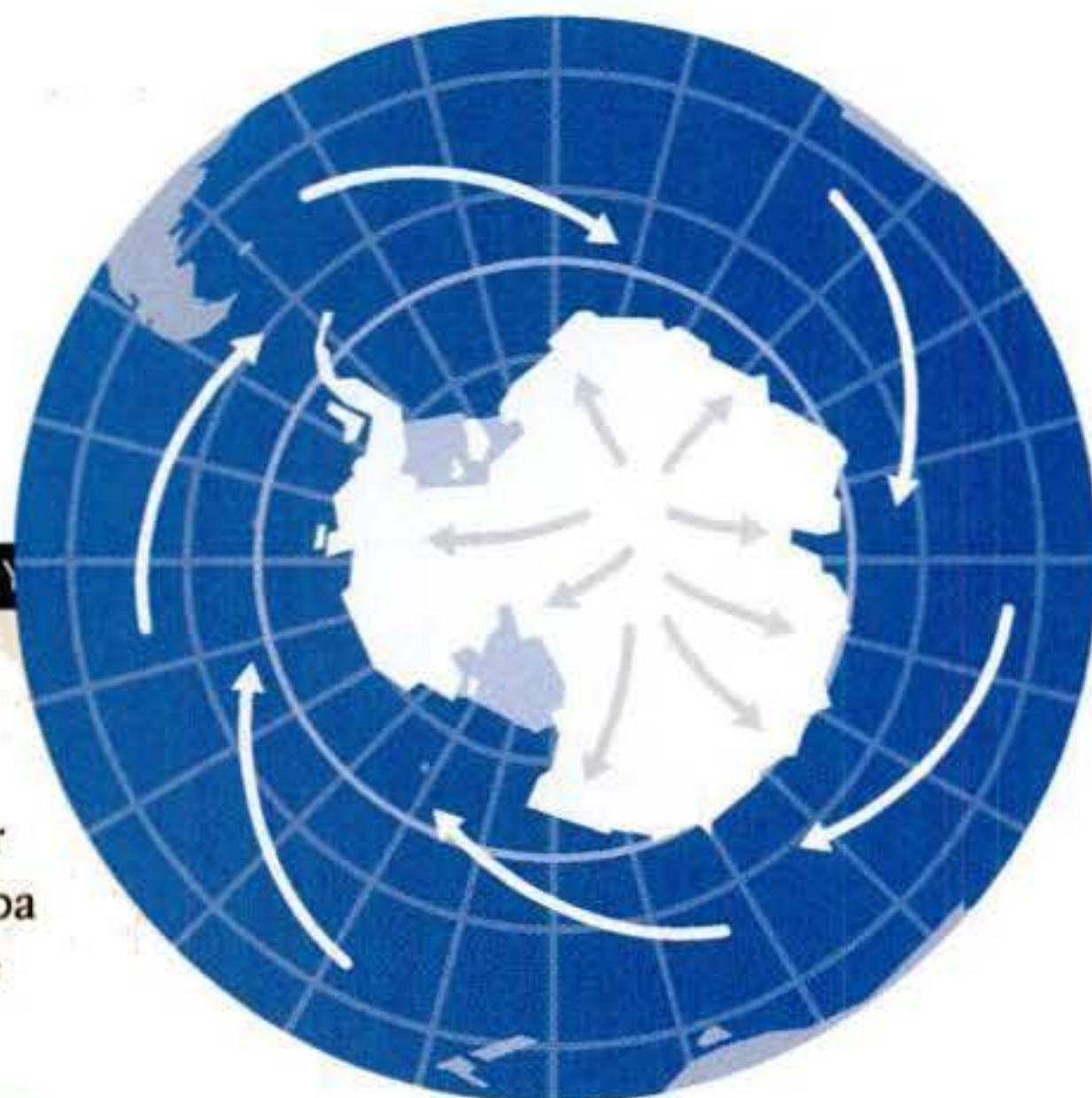
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Calling all 'Vette lovers:
The new Corvette is here.



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10 Commanding your spreadsheet by voice, personal satellite phones, tracking bees by radar, and more.



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38 Antarctic Meltdown

Is Miami in danger of becoming a scuba site? Two scientific camps disagree.

Cover photo by Galen Rowell

Founded in 1872

Volume 250

Number 2

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50 On Earhart's Wings Pilot Linda Finch aims to finish Amelia Earhart's mysterious flight.

54 Incident at Black Rock Blasting off to break the sound barrier on land, Craig Breedlove and the Spirit of America took one of racing's wildest rides.

60 21st Century Corvette Take a peek at the best two-seat sports car that about \$40,000 will buy.

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CELEBRATING
125
YEARS
OF POPULAR SCIENCE



8
Chronicling our quest to conquer the sky.



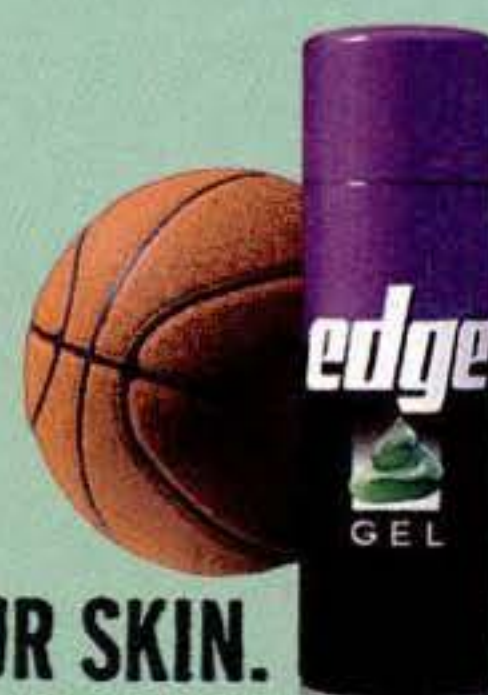
DEFENSE.

Kareem Abdul-Jabbar - Veteran Shaver



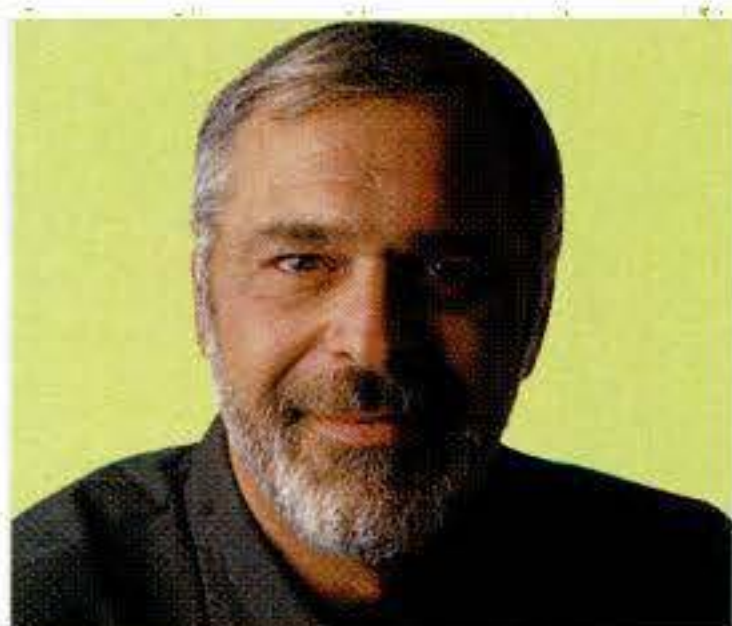
ILLEGAL DEFENSE.

Kevin Garnett - Rookie Shaver



Lose the foam. **SAVE YOUR SKIN.**

FROM THE EDITOR-IN-CHIEF



Speed Burners and Melting Ice

ANTARCTICA'S PAST IS A major part of long-range climatic forecasts. Mostly, we have presumed the south pole as a stable, icy land mass. But controversial research now suggests that trees once grew there. If the south pole was a watery world before, could it someday melt again? We sent reporter Beth Livermore to Antarctica to find out more from two sharply divided scientific camps.

There is no past indicator to tell what happens when a land vehicle breaks the sound barrier. America's most enduring speed racer, Craig Breedlove, may have the closest hint, based on his 675-mph clocking at Black Rock, Nevada, last fall. Reporter Peter Brock was there for the record-seeking run that fell short—but that surely ups the ante for new attempts this year.

The closest you may want to get to land speed excess is behind the steering wheel of the new Corvette. Don Sherman offers technical and driving analysis, and Jim Schefter takes us behind the scenes of the car's development.—*Fred Abatemarco, popscied@aol.com*

Bigger, Not Better

YOUR ARTICLE on large sport-utility vehicles had a fitting title: "Big Bad SUVs" [Dec. '96]. It disturbs me that so many people buy such vehicles without regard to safety or their own budgets. As car drivers can confirm, SUVs hinder other drivers' vision and their ability to see a few cars ahead or to look for oncoming traffic. Also, with their higher bumpers and greater mass, SUVs can cause greater danger to people in cars during accidents. Lastly, in addition to their hefty initial price, SUVs are expensive to maintain—with low gas mileage, more expensive tires, etc. I understand using SUVs for outdoor activities, but as a commuter vehicle for one or two people, are they really worth it?

*Atul H. Patel
Royal Oak, Mich.*

GPS in Action

"NEW DIRECTIONS for GPS" [Dec. '96] covered many uses for the Global Positioning System. But one that wasn't mentioned is a prison system that needs no walls or cells. When fitted with a device, some of the convicted could continue living in their own homes and working at jobs without requiring incarceration in prisons. This system, which is

under development in some areas, would be cheaper than conventional prisons (\$32 per day instead of \$47 per day), would allow tracking of those who may try to escape, and would keep the convicted employed so that they may repay victims.

*H. Stewart Bradshaw
Presiding Judge, Superior Court
Yuma County, Ariz.*

THE LAST paragraph of "New Directions for GPS" asks us to imagine playing a relaxing round of golf with the assistance of GPS. Well, at the El Conquistador country club in Oro Valley, Arizona, you can do just that. The country club has a fleet of 109 golf carts equipped with Prolink that, using differential GPS, gives yardage measurements to the hole from the cart.

KarKrzee@aol.com

Thank you for reminding us. We covered a similar system, ProShot, in "What's New" [June '96] that is used at Pebble Beach in California.

What About Kali?

I AM UPSET with the article "Internet Gaming" [Dec. '96]. You omitted Kali, an Internet gaming system that has more than 70,000 users and 200 servers in 33 countries. It has a one-time registration fee of

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\$20, including free upgrades, which is cheaper than paying monthly fees for other services. All you need is Kali, an Internet connection, and the game you want to run.

Cory Wikel
cewikel@concentric.net

Indeed, Kali is a bargain alternative we should have mentioned. But Kali is really an Internet matchmaking service, not a gaming network. The upshot is that you have to find opponents with low "ping" values, or game play can be slow. But it does work, and the selection of games is quite good. You can check it out at <http://www.kali.net>

Underground Education

IN ADDITION to using a decommissioned missile site as a home ["Home, Sweet Silo," Nov. '96], another great use is as a high school. Jackson Heights High School in Holten, Kansas, is built over a missile site and opened in the fall of 1969. Much of the underground area was converted to classrooms and also serves as a good tornado shelter.

Daymon C. DeVader, class of '85,
is4ps@topeka.cjnetworks.com

Electric Driving

I READ WITH great interest "The Electric Experience" [Nov. '96], which describes what to expect from owning General Motors' EV1 electric vehicle. My conclusion: Despite the high-tech motor and computers, it's a \$30,000 golf cart.

Ray Crim
Peninsula, Ohio

UNLIKE ELECTRIC vehicles, natural-gas vehicles use simple, proven, and existing technology—and so they would cost far less overall. If half the brouhaha and research and development on electric vehicles were expended in the natural-gas arena, the result could be many

times better for both present and future generations.

David Benedict
Beaverton, Ore.

BEFORE WE GET the electric car that we have been promised for so long, let's consider what could happen if a large number of people begin to drive electric cars. The electric-power-generating system may not be able to handle it, causing power shortages, increased rates, and the need to produce more electricity.

Boyce Griffith
Oak Ridge, Tenn.

Audacious Choice

ONLY AMERICANS could have the audacity to select FoxTrax as one of the "Best of What's New" [Dec. '96]. It is an affront to hockey fans everywhere. People who have trouble following the puck should train their eyes and learn to pick up on subtle cues—like the direction players skate or sticks clashing over an object on the ground—instead of relying on crude graphic "enhancements." Would you have selected this technology if it had been inflicted on baseball?

Andrew D. Murphy
tychoman@inforamp.net

Restricted-Use Appliances

GINA SMITH TOUTS a company's move toward specialized computers called Interactive Digital Electronic Appliances (IDEA) in Beyond Here [Nov. '96]. I fail to see how having several specialized appliances can be advantageous over a computer. A kitchen-assistant box can only give me recipes. But with a computer, I could find a recipe on a CD-ROM, print it out, save it, and then e-mail the recipe to a few of my friends.

Michael Pare
mparel@gl.umbc.edu

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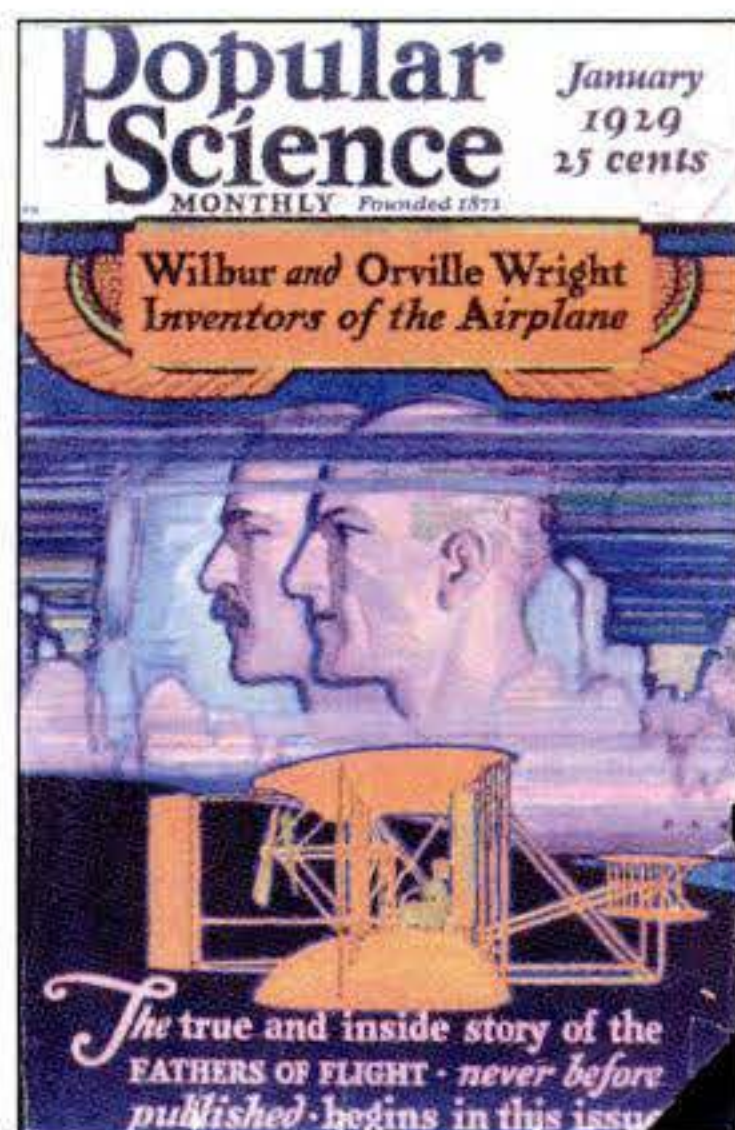
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125 YEARS OF Popular Science

EDITED BY BOB SILLERY

Aviation & Space

Chronicling man's quest to fly and to explore beyond the sky.



JANUARY 1929

Finally, Flight

THREE MONTHS after the Wright Brothers made history, we wrote in March 1904, "Too much praise cannot be awarded these gentlemen." Their accomplishments came "at considerable risk of accident...[and] without financial help." In 1929, we celebrated the 25th anniversary of their achievement.



FEBRUARY 1983

Invisible Bomber

BREAKING NEW GROUND in covering stealth aircraft, we revealed "the secrets of the plane that radar can't see."

Comet Collision

THE SHOEMAKER-LEVY comet's collision with Jupiter was the celestial event of the century, pelting the planet with the force of 50 million atomic bombs. Virtually every telescope in the world was directed on the event, as was the editorial focus of POPULAR SCIENCE.

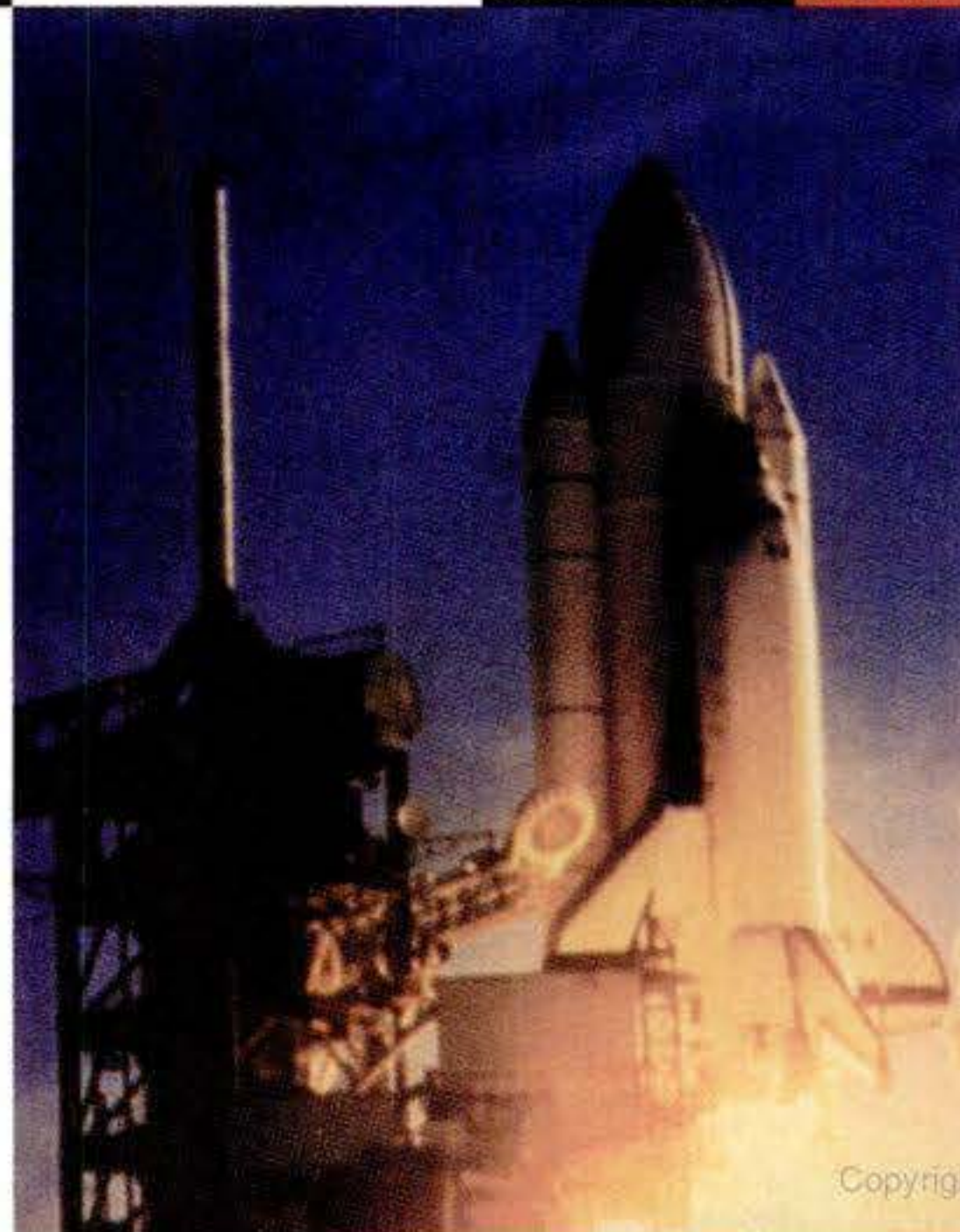
JULY 1994



Columbia's Triumph

REPORTING FROM near the launch of the space shuttle Columbia, the first reusable spacecraft, we described the "crackling sounds of rockets" shaking the ground and "wrapping us in cocoons of noise and light." It was, we said, the dawn of a new age of space travel.

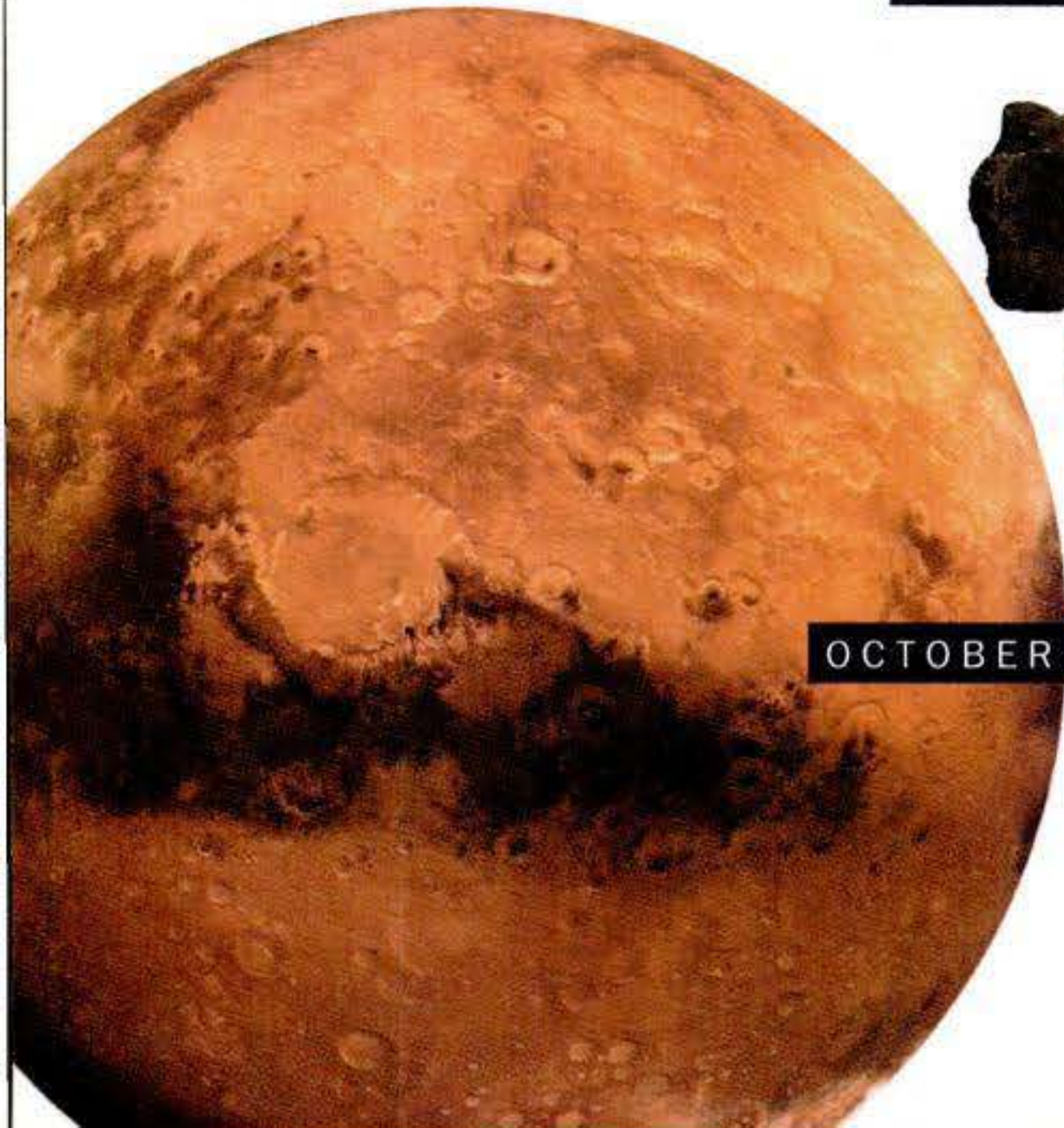
AUG/SEPT 1981



At Last, Company

AFTER painstaking detective work, scientists announced they had found signs of fossilized life on a meteor from Mars. Even skeptics admitted it might not be a false alarm.

OCTOBER 1996



JULY 1969

One Giant Leap

OUR ISSUE accompanied Neil Armstrong's first strides on the lunar surface, providing a step-by-step guide to what we termed "the conquest of the greatest engineering challenge we have ever faced."

CORBIS BETTMAN



SEPTEMBER 1971

Black Holes

WHEN SENSORS aboard the Explorer 42 spacecraft detected an X-ray source in the constellation Cygnus, scientists hailed the discovery of an "extraordinary new phenomenon"—a black hole. Discovery of more massive holes lay ahead.

Breaking the Sound Barrier

BLASTING AVIATION into the supersonic era in October 1947, Capt. Chuck Yeager became a hero with the right stuff. POPULAR SCIENCE previewed Yeager's craft, the Bell X-1.



JULY 1941

Sikorsky's Helicopter

SETTING A DURATION record (a little more than an hour) for such craft, Igor Sikorsky's VS-300A helicopter helped expand aviation's capabilities for short hops, from airport to city, from city to suburb—even from battlefield to battlefield.

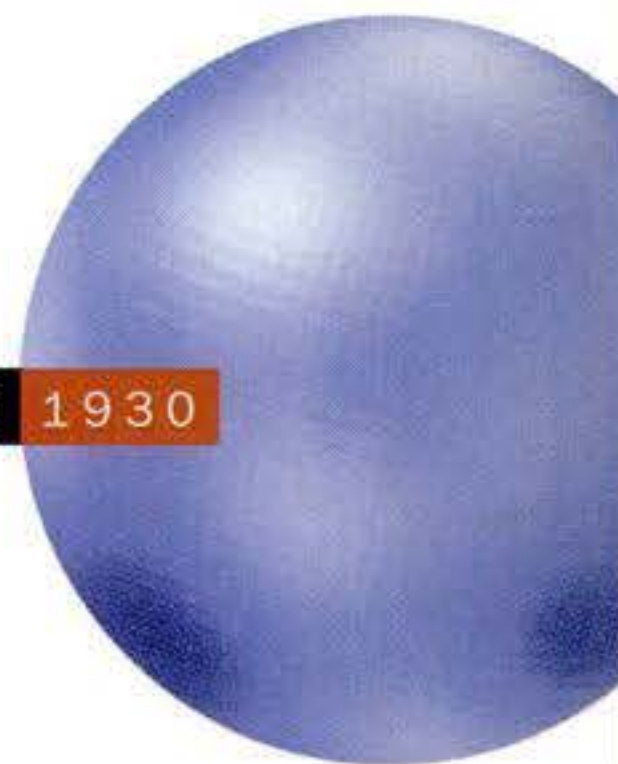


JANUARY 1947

Discovery of Pluto

"IT BEHAVES differently from other planets. Its orbit is so askew that astronomers hesitate to declare it a planet with certainty," we wrote of the discovery of the ninth planet in our solar system.

JUNE 1930



Also Noted...

- **Requirements for flight** We speculate on what it will take, **JANUARY 1894**
- **Robert Goddard's** plan to hit the moon with a rocket, **APRIL 1920**
- **Boeing 707s** and other planes bring the corners of the globe within the reach of tourists and business travelers, **AUGUST 1956**
- **Walking in space** We detail

- the challenges astronauts face in **FEBRUARY 1967**
- **Concorde SST** We take our readers into the supersonic transport's cockpit, **OCTOBER 1973**
- **The Hubble Telescope** We spell out "The Trouble with Hubble" in **OCTOBER 1990**
- **Discovery** We analyze NASA's smaller, faster, cheaper missions, **MARCH 1996**
- **VentureStar** We present the shuttle that you may someday fly, **OCTOBER 1996**



AUGUST 1927

The Spirit of St. Louis

ON MAY 22, 1927, CHARLES LINDBERGH was our hero, but a few months later, we profiled his airborne partner, analyzing part by part the marvels of the monoplane, its engine, and its precision instruments.

WHAT'S NEW

EDITED BY CANDACE GOLANSKI

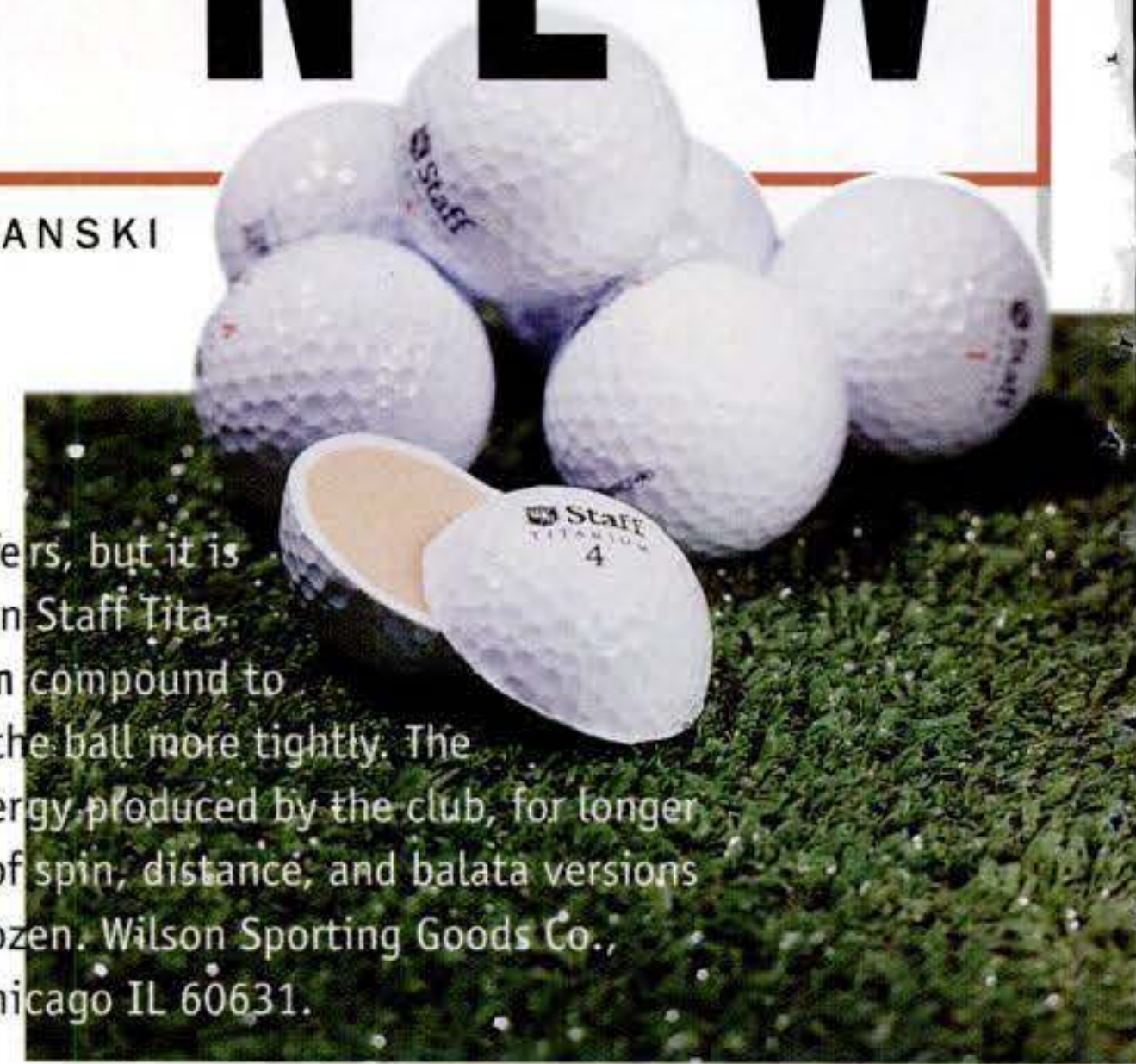
Stripped-Down PC

THIS PC COSTS only \$999, but still packs some hardware punch. The muscle comes from a 586-level AMD 75MHz processor, a 1GB hard drive, 16MB of RAM, a 4X CD-ROM drive, stereo speakers, and a 33.6Kbps modem. Most of the software normally bundled with PCs is absent, however, which accounts for the low price tag. You do get Windows 95 and an Internet browser from MindSpring. The machine is small, thanks in part to a 10.4-inch LCD screen. Overall dimensions are a mere 11 by 15 by 3.25 inches. Monorail, Inc., 2000 Powers Ferry Rd., Marietta GA 30067.



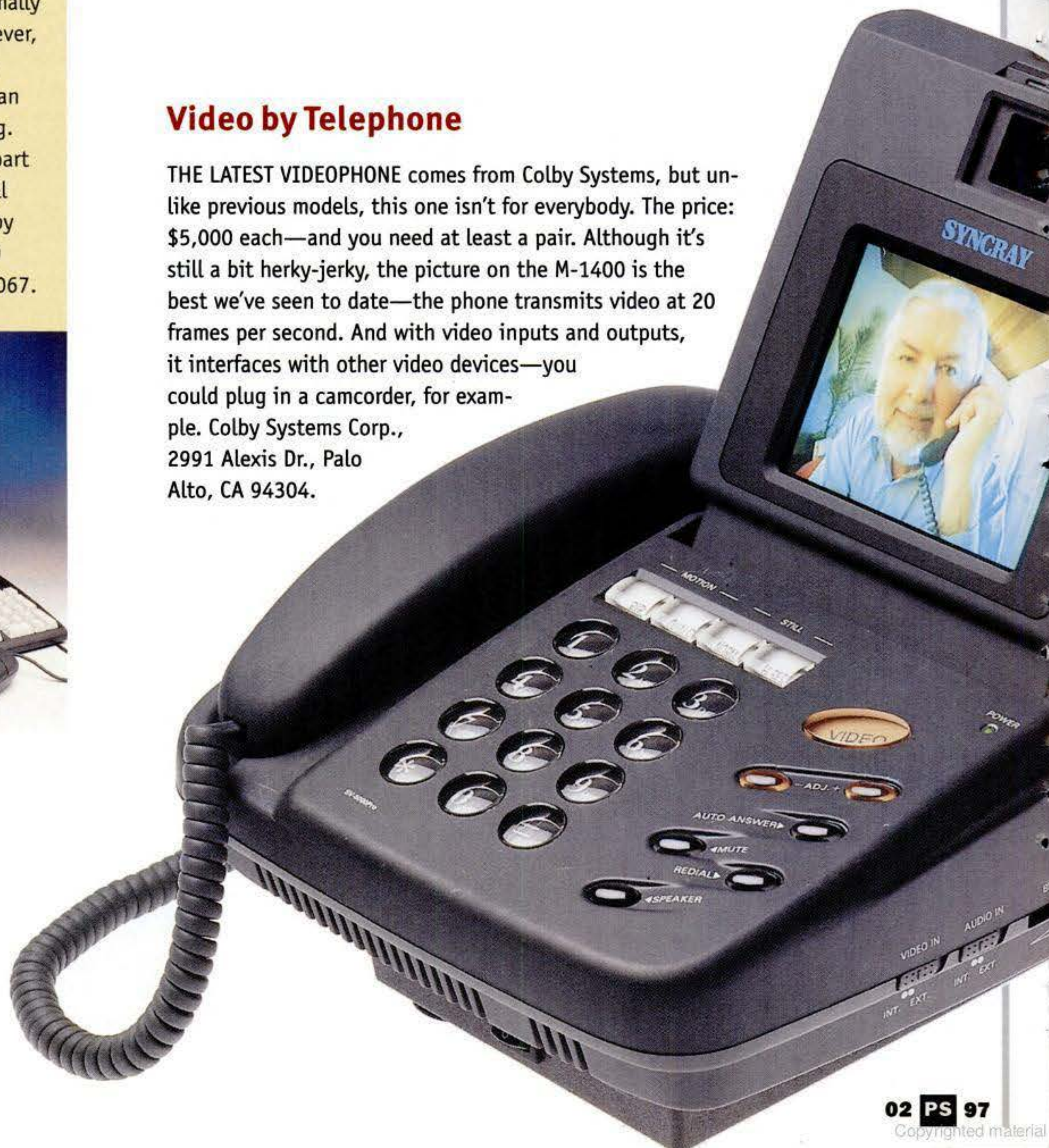
Flying Titanium

TITANIUM ISN'T new to golfers, but it is new to golf balls. The Wilson Staff Titanium Series uses a titanium compound to bond the core materials of the ball more tightly. The ball retains more of the energy produced by the club, for longer drives. The Series consists of spin, distance, and balata versions priced from \$35 to \$43 a dozen. Wilson Sporting Goods Co., 8700 W. Bryn Mawr Ave., Chicago IL 60631.



Video by Telephone

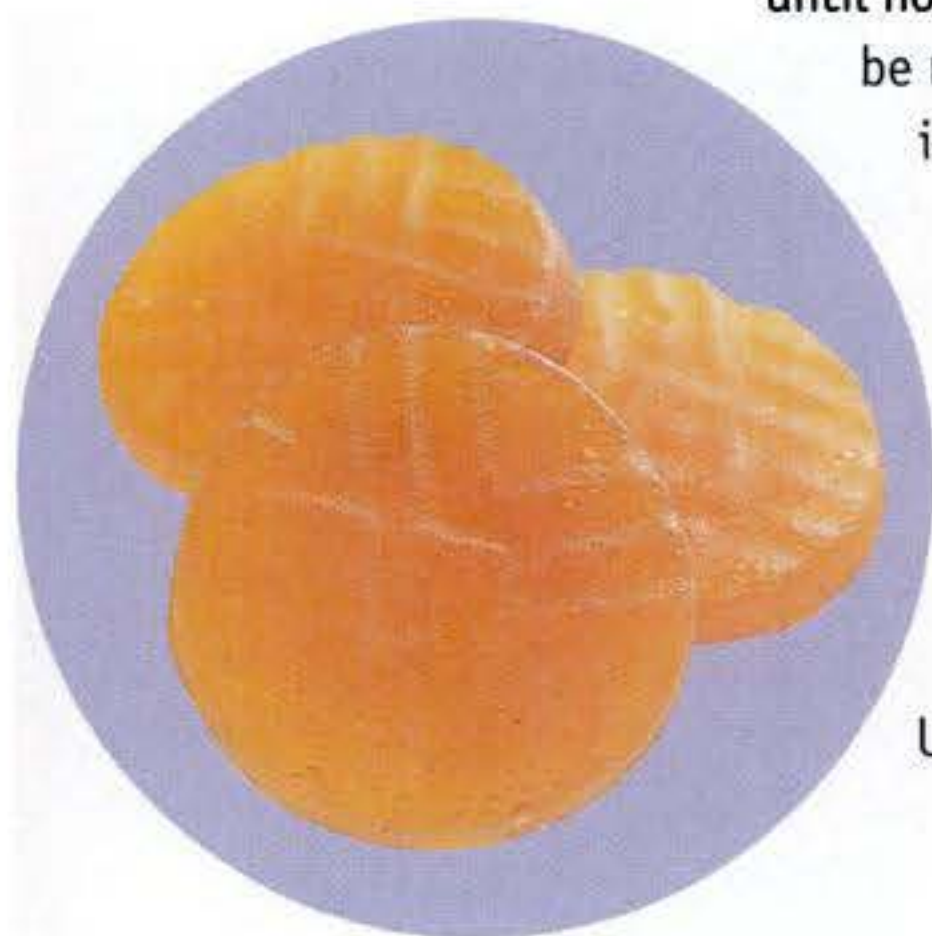
THE LATEST VIDEOPHONE comes from Colby Systems, but unlike previous models, this one isn't for everybody. The price: \$5,000 each—and you need at least a pair. Although it's still a bit herky-jerky, the picture on the M-1400 is the best we've seen to date—the phone transmits video at 20 frames per second. And with video inputs and outputs, it interfaces with other video devices—you could plug in a camcorder, for example. Colby Systems Corp., 2991 Alexis Dr., Palo Alto, CA 94304.



Candy from Fruit?

SOON YOU COULD satisfy your sweet tooth more nutritiously with candy made entirely from fruit. A formula using fruit puree, starch, and gelatin allows for fruit content far greater than 5 percent, the highest concentration

until now. The concoction can be molded and extruded into a variety of fun shapes. Though the formula can yield as much as 30 percent fruit now, researchers are aiming for the whole banana. Agricultural Research Service, USDA, Albany CA 94710.



Snow Kart

A SLED THAT handles like a toboggan, SkiKart offers the excitement of downhill skiing from the seat of your pants. Zigzag through a slalom as the flexible seat and elongated skis combine for deft responsiveness. It's designed to dismantle and carry easily. You can purchase SkiKart by mail for about \$385, and it's expected to be available soon in the United States. Raymond Sims Ltd., Trentside North, West Bridgford, Nottingham NG2 5FA, England.



Online Fun and Games

WHAT DO YOU call a cross between static CD-ROMs and ever-changing online services? The folks at 7th Level (972-498-8100) call it KidsWorld, a new Web-based entertainment and education service for kids. The \$10 monthly fee allows access to myriad games and learning activities on the KidsWorld site (www.kidsworld.com). The subscription also gets you the company's CD-ROM titles, such as Virgil Reality and Lil' Howie, and a free CD-ROM every three months, effectively paying for itself.



Mini Disc Camera

THE MINI Disc didn't quite catch on in the United States as a music storage device, but Sharp hopes for a warmer reception when its MD Data Camera MD-PS1 hits our shores later this year. The digital camera stores up to 2,000 images on one disc, and can record audio when the image is captured, or add sound later on. Images are stored in 30 blocks of 72 images and can be deleted within the camera. The camera is available only in Japan for an undisclosed price.





Super Shovel

THIS COMPACT, lightweight shovel invented by engineers at Loughborough University in England would be a wise addition to the backpack of anyone planning a serious winter trek. The prototype shovel folds flat, taking up about the same space as a large book, but it is strong enough for digging out of heavy snow. Anna Seddon, Loughborough University, Loughborough, Leicestershire, LE11 3TU, England.



Eyes on the Scene

MEDIC-CAM, developed by the Army Research Laboratory, allows medics in the field to transmit video footage of wounded soldiers via satellite to doctors virtually anywhere in the world. A miniature 7mm-diameter, high-resolution color camera mounted on a lightweight visor, along with a microphone and earpiece, allow the doctor and medic to communicate. Currently used by the military, the device could aid rescue operations during earthquakes, hurricanes, terrorist bombings, or other disasters.

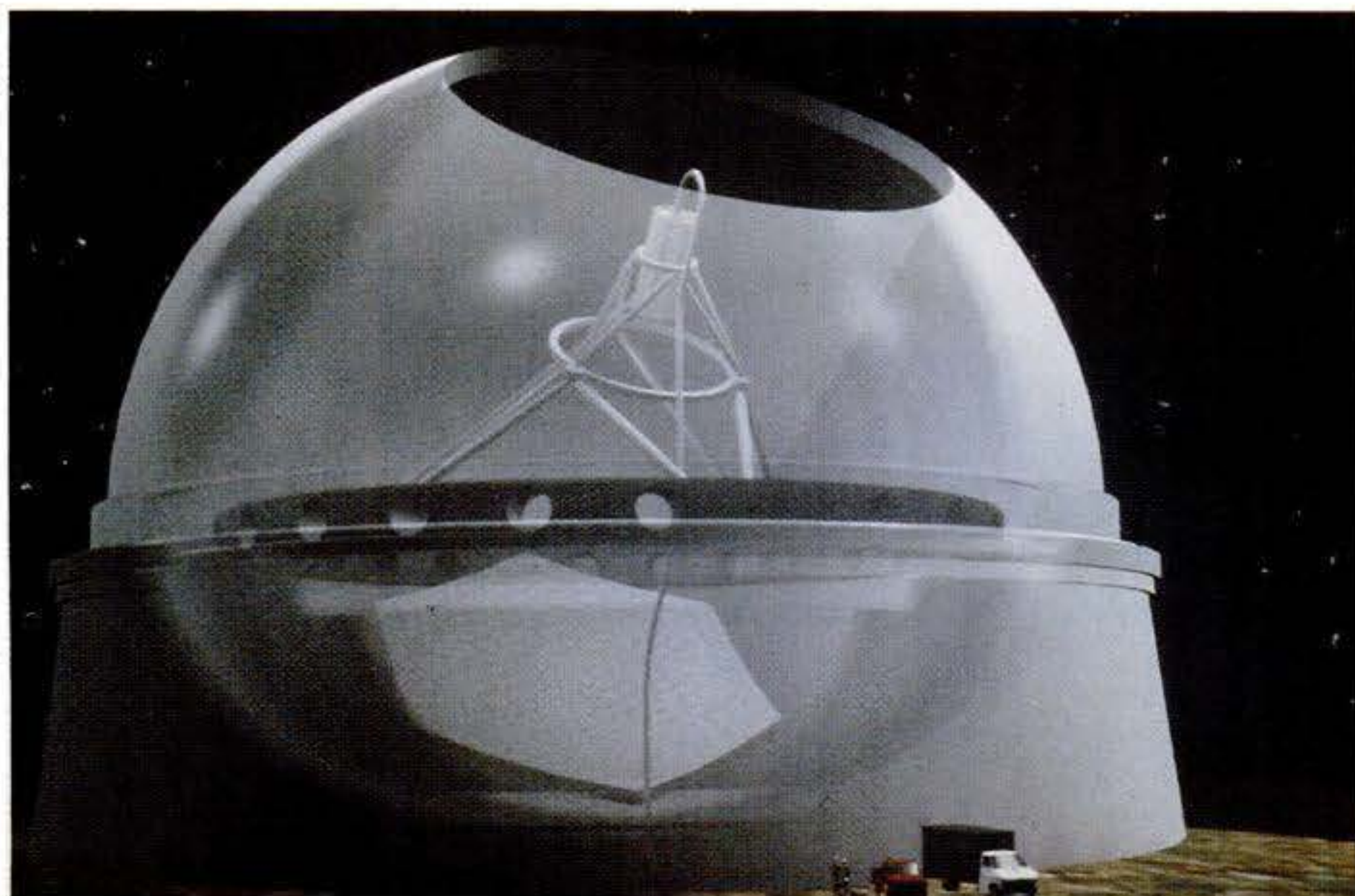
Custom Dictation

DRAGONDICTATE FOR Windows Singles is a series of voice-recognition programs that are customized to work with popular applications such as Word, WordPerfect, Excel, 1-2-3, and Notes. Each uses Dragon Systems' large-vocabulary speech-recognition engine, so you can dictate text as well as issue program commands. A Pentium system with 16MB of memory is recommended. Each sells for \$99. Dragon Systems, Inc., 320 Nevada St., Newton MA 02160; 800-825-5897.



Big New Looker

WHEN COMPLETED, this optical telescope will boast a mirror surface eight times larger than any before it—for views of stars 10 times fainter than with today's ground-based telescopes. The Extremely Large Telescope will forgo expensive tracking motors and instead fix the 29-meter mirror at 55 degrees, enabling it to scan 70 percent of the sky. Construction may begin by 2000 and could cost \$200 million. University of Texas at Austin, McDonald Observatory, Austin TX 78712.



New Dune Buggy

THE HEULIEZ Intruder all-terrain vehicle not only looks tough, it is tough. With wide tires on 17-inch wheels and nearly 12 inches of ground clearance, the ATV is at home on the roughest ground or in streams as deep as two feet. The Mercedes 3.2-liter 210-hp four-speed automatic engine propels the vehicle up 80 percent grades. Locking differentials enhance off-road traction. Groupe Henri Heuliez, 252 Boulevard St. Germain, 75007 Paris, France.

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S3d logo software, you get the best 2D graphics,

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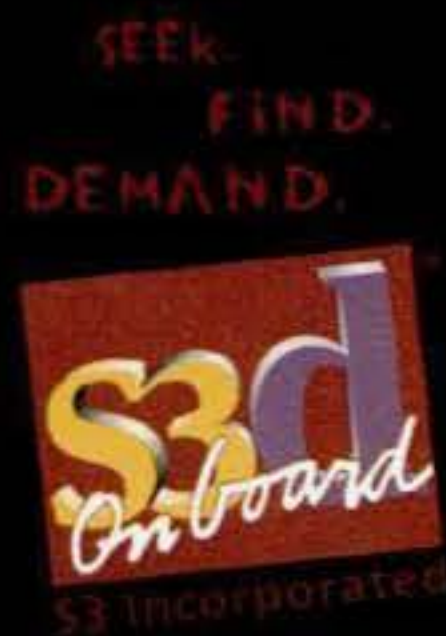
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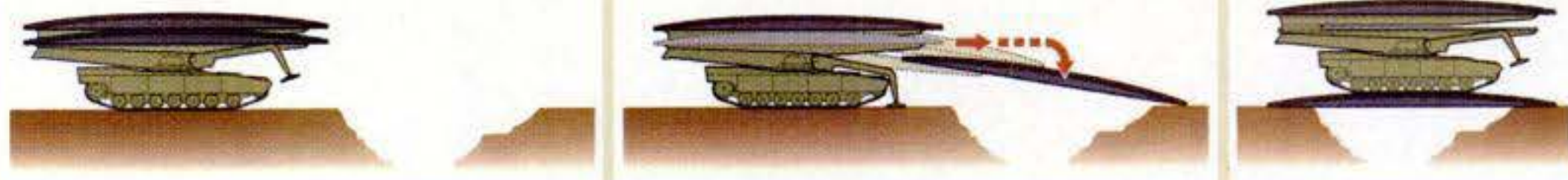


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Assault Bridge

TECHNOLOGY BEING developed for composite mobile assault bridges, which enable armed forces to move over ravines and ditches, could assist the nation's infrastructure as well. A prototype design now being tested is lightweight—less than 9,000 pounds, compared with 12,500 pounds for existing metallic designs—yet strong and durable enough to support 70-ton tanks. The design is being developed by the University of California at San Diego with funding from the Defense Advanced Research Projects Agency and the Federal Highway Administration.



Space Phones

PERSONAL SATELLITE telephones will make it easier and cheaper for you to phone home—even from the most remote places on earth. Globalstar hopes to begin service in two years with stationary rural phones (shown) and handheld models, rather than today's briefcase- and laptop-size phones. The system will use 48 low-orbiting satellites that will be launched starting next July. Service costs will vary depending on carrier, but may be as little as half of today's costs. Globalstar Limited Partners, 3200 Zanker Rd., Box 640670, San Jose CA 95164-0670.

This Year's Model

MICROSOFT OFFICE 97, the latest version of the productivity software ensemble used more than any other, includes new and more tightly integrated editions of its Word editor, Excel spreadsheet, and PowerPoint presentation graphics. A "professional" version of the set also includes a new edition of its Access database. Among the many improvements: Word's grammar checker proofreads as you type, PowerPoint automatically creates a summary slide, and Access lets you create databases that can be searched over the Internet. Microsoft (800-426-9400) has not yet set pricing. <http://www.microsoft.com>



Multimedia Master

HEWLETT-PACKARD'S 7300 series of Pavilion home PCs for 1997 are loaded with the latest multimedia gear. The Pavilion 7350P, for example, is powered by a Pentium/166 processor and comes with a 16X CD-ROM drive, 3-D graphics, a high-speed Universal Serial Bus (USB) port, and video-capture capability. It also comes with a built-in photo scanner and a new multimedia keyboard with volume control and phone message retrieval buttons, among other features. The 7350P model sells for about \$2,300, not including monitor. <http://www.hp.com.pchome1>



Mirror Times

THE VERY LARGE Telescope, to be completed in the Chilean Andes by the end of the decade, will need very large mirrors. In fact, its four mirrors, each measuring 8.2 meters in diameter, are the largest in the world. After formation with a new spin-casting technique, the mirrors required cooling for several months. The European Southern Observatory will use the telescope to look far back into the universe's past.



Take 2 CD-ROMs for \$9.95 ea.

**PLUS 1 MORE
AT GREAT SAVINGS!**
(SEE DETAILS BELOW.)



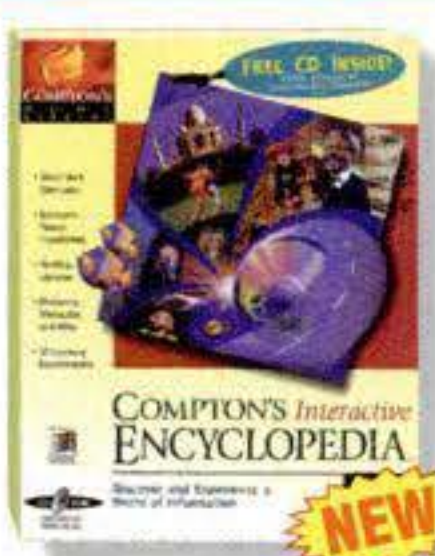
WinDelete

A complete Uninstaller to optimize your system, removing useless and memory-consuming extensions, lost files, duplicates and unnecessary programs. Also includes virus protection, diagnostics and more. **IMSI Utilities** 5084504
WIN3.1 386, 8mb, M



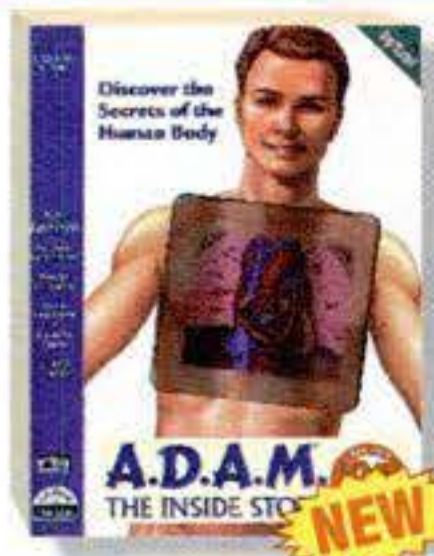
Home Phone '96

85 million white page listings! Search by name to get phone number or address with lightning speed. All with unlimited downloading and usage. Find old buddies and friends, family members, old flames, college roomies. **ProCD Home/Personal** 5090006
DOS 386 or MAC 68030, 4mb, M



Compton's Interactive Encyclopedia '97

Create multimedia presentations—Explore more than 37,000 articles, 100 full-motion videos, slides shows, animations, and presentations and 8,000 photographs. **Compton's New Media General Ref.** 5090501
WIN3.1 486/66, 8mb, M



A.D.A.M.: The Inside Story '97

The new edition of the hit program offering detailed information about the human body and its health and maintenance. Features one-button internet access, 3-D graphics, on-line video doctor, quizzes and more. **A.D.A.M. Software, Inc. Medical Ref.** 5083803
WIN3.1 486/66 or MAC 68040, 8mb, M



The Oregon Trail II

Learn about the Old West and solve a whole new set of challenges following any of hundreds of possible paths. Begin as a Greenhorn amongst other emigrants and advance to the rank of trail guide! Ages 10 to adult. **MECC Children's Ed.** 5078308
WIN3.1 486, 4mb or MAC 68030, 5mb, M



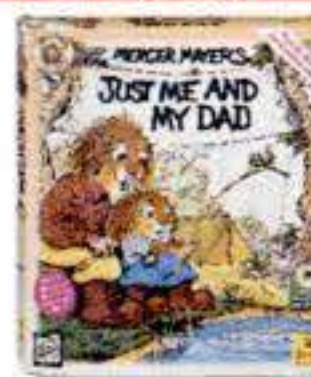
First Aid '95 Deluxe

Utilities 5066402
WIN3.1 386, 4mb, M **Cybermedia**



Masterclips 35,000 Premium Image Collection

Clip-Art Library 5084801
WIN3.1 386, 4mb, M, K, P, **IMSI**



Just Me & My Dad

Children's Ed. 5067400
WIN3.1 486, 4mb or
MAC LCIII, 8mb, M, **GT Interactive**

NEW

Invention Studio

WIN3.1 486/50, 8mb, M, **Discovery Channel Children's Ed.** 5086806

Java Programmer's Library

WIN3.1 386, 4mb, M, **Jamsa Press Computer Tutor.** 5073200

NHL Powerplay '96 Hockey

WIN '95 486/66, 8mb, M, J, K, **Virgin Entertainment Sports** 5089701

Muppet Treasure Island

WIN3.1 486/66, 8mb, M, **Activision, Inc. Adventure** 5085303

808 Great Letters

WIN3.1 386, 4mb, M, **Great Bear Gen. Reference** 5041702

Connections

WIN3.1 486/33 or MAC 68040, 8mb, M, **Discovery Channel Adventure** 5071501

The 7th Guest

DOS 386 or MAC LCIII, 4mb, M, **Virgin Entertainment Interact. Game** 5004700

Command And Conquer

DOS 486/66, 8mb, M, **Virgin Entertainment Strategy Game** 5050208

Floorplan Plus 3D

WIN3.1 386, 4mb, M, **IMSI Home/Personal** 5084702

Mixed Up Mother Goose Deluxe

WIN3.1 386 or MAC LCIII, 8mb, M, **Sierra Children's Ed.** 5042304

Virusnet

WIN3.1 386, 2mb, M, **Just Softworks Utilities** 5080106

Spycraft: The Great Game

DOS 486/66 or MAC 68030, 8mb, M, **Activision, Inc. Adventure** 5063201

Nascar Racing

DOS 386/40, 8mb, M, J, K, **Sierra Driving Sim.** 5001300

Berlitz Live Spanish

WIN3.1 386 or MAC Classic, 4mb, M, **Sierra Language Tutor** 5043401

Precision Mapping 2.0

WIN3.1 386, 4mb, M, **Just Softworks Travel** 5071204

The Lost Mind Of Dr. Brain

WIN3.1 486 or MAC LCIII, 4mb, M, **Sierra Children's Ed.** 5037502

Success With Windows '95

WIN '95 486, 8mb, M, **Jamsa Press Computer Tutor.** 5081302

The Unexplained

WIN3.1 486/50, 8mb, M, **Flagtower Multimedia Historical** 5079801

Jumpstart Kindergarten

DOS/WIN3.1 386, 1 mb or MAC LCIII, 4mb, M, **Knowledge Adventure Children's Ed.** 5027701

Nickelodeon: Director's Lab

WIN3.1 486, 8mb, M, **Viacom New Media Strategy Game** 5089404

NCAA Championship Basketball

DOS 486/66, 8mb, J, K, **GTE Interactive Sports** 5089503

NEW

Zork Nemesis

DOS 486/66, 8mb or MAC PMAC, 16mb, M, **Activision, Inc. Adventure** 5065602

World Beer Hunter

WIN3.1 486/66 or MAC 68030, 4mb, M, **Discovery Channel Gen. Interest** 5087408

Gabriel Knight: The Beast Within

WIN3.1 486/33 or MAC 68040, 8mb, M, **Sierra Adventure** 5060405

Are You Afraid Of The Dark?

DOS 386/33 or MAC LC, 4mb, M, **Viacom New Media Children's Ed.** 5072905

Nick Jr. Play Math

WIN3.1 486/33 or MAC 68030, 8mb, M, K, **Viacom New Media Children's Ed.** 5072707

Learn Netscape Navigator

Quick & Easy Computer Tutor. 5082508

Nine Month Miracle

WIN3.1 386/33 or MAC LCII, 8mb, M, **A.D.A.M. Software, Inc. Medical Ref.** 5060603

Mavis Beacon Teaches Typing 4.0

WIN3.1 386/33, 8mb, M, K, **Mindscape Typing Tutorial** 5052402

Project Manager Pro

WIN3.1 386/33, 8mb, M, **Softkey Publishing Home/Personal** 5071303

Resume Maker Deluxe CD

WIN3.1 386/33, 8mb, M, K, P, **Individual Software, Inc. Home/Personal** 5050703

Corel Gallery

WIN3.1 386, 4mb or MAC LCII, 2mb, M, K, P, **Corel Clip Art Library** 5010301

Phantasmagoria

DOS/WIN3.1 486/66 or MAC LCIII, 8mb, M, **Sierra Interact. Game** 5004502

Freddie Fish And The Case

Of The Missing Kelp Seeds Children's Ed. 5085709

Chessmaster 5000

WIN '95 486/66, 8mb, M, **Mindscape Strategy Game** 5083605

Compton's Complete Street Guide

WIN3.1 386, 4mb, M, **Compton's New Media Travel** 5065909

Trivial Pursuit

WIN3.1 386 or MAC LCIII, 4mb, M, **Virgin Interactive Strategy Game** 5027404

Learn Internet Explorer

Quick & Easy Internet Guide. 5091202

Day Planner Pro

WIN3.1 486, 4mb, M, **Softkey Publishing Home/Personal** 5070701

The 11th Hour

DOS 486/66, 8mb, M, **Virgin Entertainment Interact. Game** 5054309

Highlights Interactive

WIN3.1 486/33 or MAC 68030, 8mb, M, **Creative Multimedia Children's Ed.** 5086707



Duke Nukem 3D

Arcade Style 5077607
DOS 486, 8mb, M, **Form Gen**



Jumpstart Pre-K

Children's Ed. 5091400
WIN3.1 486/33, 8mb or
MAC 68040, M, **Knowledge Adventure**



Mechwarrior 2 Mercenaries

Arcade Style 5091905
DOS 486/66, 8mb, M, J, K, **Activision, Inc.**

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☐ Education

(includes children's titles)

☐ Edutainment

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No Tools Needed

NO MORE time-consuming battles with a wrench to level the cutting deck on the WideBody Lawn Tractor from Murray of Brentwood, Tennessee: You can make the adjustment in less than a minute, without tools. A lever drops the deck onto a flat surface—a garage floor, say—and then can be used to lift the deck back into place. The tractors will range from about \$725 to \$1,400, depending on the model, and will sell nationwide this spring.



Me on CD

PHILIPS MEDIA'S A Story About Me: In the Backyard CD-ROM is more than interactive—it's personal. Using a scanner or digital camera, you can add photographs of family or friends directly into the program. Kids can watch themselves ride on a bumble bee, for example, plus record their own voices and narrate the story. The \$40 program runs on Macs or Windows PCs.

Water Rinse

FILTER MEMBRANES for water purifiers that work at a house's point of entry typically last one to three years and can cost \$60 to \$100. The Kinetico Drinking Water II Plus helps double the life span of the membranes. A small bladder collects water from the unit's reverse-osmosis filter. This pure water then rinses the membrane surface, clearing life-shortening deposits. Prices range from \$900 to \$1,100, installed. Kinetico Inc., 10845 Kinsman Rd., Box 193, Newbury OH 44065.



Sea Power

THE LA RANCE TIDAL power plant in the Brittany region of France is the largest and oldest such facility in the world, producing 240 megawatts. Now, after 30 years of operation, the plant is getting a major tune-up: A 10-year \$78 million project will renovate each of the 24 turbines while the plant continues to run. The turbines are spun, producing electricity, as the tides flow and ebb each day. EDF, Service de Presse, 2, rue Louis Mural, 75384 Paris Cedex 08, France.





It's full
of surprises.



If this doesn't



...this cer

Comfort & Convenience

- Dakota has more room.



- Dakota Club Cab has more rear seating capacity.
- Dakota Club Cab's rear passengers face forward.
- Dakota is the only one to offer a 40/20/40 split bench seat with mini business console.



- Dakota Club Cab is the only one with storage bins under the rear seat.
- Dakota is the only one to offer an overhead storage console.



- Dakota is the only one with a counter-balanced hood, which stays open without a prop rod.
- Dakota is the only one to include a cassette player with the standard radio.

Dodge Dakota

Regular Cab:
56.4 cu. ft.
Club Cab (front):
56.4 cu. ft.
Club Cab (back):
28.3 cu. ft.
Total Club Cab:
84.7 cu. ft.

3

Forward-facing
bench seat

40/20/40 split bench

Standard

Available overhead
console with eyeglass
storage, garage door
opener storage, trip
computer, temperature
gauge and compass

Counter-balanced

AM/FM cassette

Ford Ranger

Regular Cab:
52.5 cu. ft.
Club Cab (front):
52.7 cu. ft.
Club Cab (back):
13.6 cu. ft.
Total Club Cab:
66.3 cu. ft.

2

Inward-facing
jump seats

Not available

Not available

Not available

Prop-rod

AM/FM

Chevrolet S-10

Regular Cab:
55.6 cu. ft.
Club Cab (front):
55.6 cu. ft.
Club Cab (back):
9.7 cu. ft.
Total Club Cab:
65.3 cu. ft.

2

Inward-facing
jump seats

Not available

Not available

Not available

Prop-rod

AM/FM

tainly will.

Safety Features/Durability

- Dakota is the only one with standard dual airbags.[†]



- Dakota is the only one in which the seat belt travels with the front seat as a standard feature.

- Dakota Club Cab is the only one to feature a shoulder belt for driver- and passenger-side rear occupants.



- Dakota is the only one to offer a self-dimming rear-view mirror.

- Dakota offers bigger exterior mirrors, for a large field of vision.

- Dakota is the only one to offer the Early Accident Response System, a feature designed to unlock the doors and turn on the dome light to facilitate rescue in the event of certain types of collisions.

- Dakota is the only one with an electro-coat painted frame for superior corrosion protection and durability.



Dodge Dakota

Standard dual airbags

Standard

Standard

Available

50.0 sq. in.

Included with power door locks option

Electro-coat painted

Ford Ranger

Standard driver-side airbag, optional passenger-side airbag

Optional

Lap belts only

Not available

31.5 sq. in.

Not available

Wax coating

Chevrolet S-10

Standard driver-side airbag only

Not available

Lap belts only

Not available

41.0 sq. in.

Not available

Wax coating

surprise you...



DAKOTA

We stand behind the name Dakota, with our Customer One Care™ 3-year or 36,000-mile bumper-to-bumper warranty and 3/36 Roadside Assistance.**

Rear-wheel anti-lock brakes are standard on the all-new Dakota. And for extra control when braking and steering, you can opt for four-wheel anti-lock brakes.



The new Dakota can take you almost anywhere. And its precise

handling, cavernous interior and numerous comforts make getting there just as enjoyable as being there.



You can opt for a premium Infinity® stereo system with cassette and CD player in the new Dodge Dakota. Eight speakers in six locations kick out some real concert-quality sound.



There are up to five cupholders in all. Hey, you never know when some thirsty friends are going to need a ride.

The bed can be turned into a shelf, so you don't have to take everything out just to get to that one thing on the bottom. It's a convenience on top of a convenience.



Surprise, surprise, surprise!



We code many of the new Dakota's plastic parts for the day they can be recycled. Because, like you, we think the world of the environment.

Once again, Dodge opens new doors for Dakota owners. This time, with available remote keyless entry.



For more surprising facts, call 1-800-4-A-DODGE, or visit our Web site at <http://www.4adodge.com>



Club Cab Sport 4x4

Sport 4x2

The New Dodge Dakota



Towing & Payload

- Dakota has up to 1300 lbs. more available towing.

- Dakota has over 900 lbs. more available payload.

- Dakota offers a greater maximum GVWR.

- Dakota offers a greater maximum GCWR.

- Dakota has a larger bed.

- Dakota long bed is the only one that holds 4'x8' building materials with the tailgate closed.

Dodge Dakota

6800 lbs.

2600 lbs.

5900 lbs.

10,500 lbs.

Short Bed

Length: 77.9"

Width: 57.8"

Depth: 17.5"

Volume: 46.5 cu. ft.

Long Bed

Length: 96.4"

Width: 57.8"

Depth: 17.5"

Volume: 56.4 cu. ft.

Ford Ranger

6000 lbs.

1650 lbs.

5160 lbs.

9500 lbs.

Short Bed

Length: 71.8"

Width: 54.4"

Depth: 16.4"

Volume: 37.4 cu. ft.

Long Bed

Length: 83.8"

Width: 54.4"

Depth: 16.4"

Volume: 43.5 cu. ft.

Chevrolet S-10

5500 lbs.

1509 lbs.

5150 lbs.

9500 lbs.

Short Bed

Length: 72.8"

Width: 54.9"

Depth: 17.1"

Volume: 39.4 cu. ft.

Long Bed

Length: 88.8"

Width: 54.9"

Depth: 17.1"

Volume: 48.1 cu. ft.

Comparisons vs. Ford Ranger & Chevy S-10 based on data available at time of printing.

† Always wear your seat belt for a fully effective airbag. Rearward-facing child seats cannot be used in standard cab models.

*4x2 model; 4x4 model: 108.2" *** See limited warranty & restrictions at dealer. Excludes normal maintenance & wear items.

Paper contains ten percent recycled material. ♻



The New Dodge Dakota
It's full of surprises.



Copyrighted material

Power

- Dakota offers three Magnum® engines: a standard I-4, a V-6 and the only V-8 in the class.

- Dakota has more available horsepower.

- Dakota has more available torque.

- Dakota has more standard horsepower.



- Dakota has more standard torque.

Dodge Dakota

5.2L V-8

230 @ 4400 rpm

300 lb/ft @ 3200 rpm

2.5L I-4
120 @ 5200 rpm

145 lb/ft @ 3250 rpm

Ford Ranger

4.0L V-6

160 @ 4200 rpm

220 lb/ft @ 3000 rpm

2.3L I-4
112 @ 4800 rpm

135 lb/ft @ 2400 rpm

Chevrolet S-10

4.3L V-6

190 @ 4400 rpm

250 lb/ft @ 2800 rpm

2.2L I-4
118 @ 5200 rpm

130 lb/ft @ 2800 rpm

Ride & Handling

- Dakota has a wider track, which enhances stability.

- Dakota has a longer wheelbase, which makes for a smooth ride.



- Dakota's turning circle is smaller than Ranger's and S-10's short wheelbase and Club Cab 2WD models.

- Dakota has standard power rack-and-pinion steering on 4x2 models.

- Dakota 4x2 has larger standard tires for great road contact and traction.

Dodge Dakota

Front/Rear
2WD 60.5"/61.5"
4WD 60.8"/61.5"

(SWB/Club Cab)
112.0"/130.9"

36.0'/41.2'

Standard

P215/75R15

Ford Ranger

Front/Rear
2WD 56.6"/57.3"
4WD 58.3"/57.3"

(SWB/Club Cab)
107.9"*/125.4"

36.5'/41.6'

Rack-and-pinion
not available

P195/70R14

Chevrolet S-10

Front/Rear
2WD 55.0"/54.6"
4WD 57.2"/55.1"

(SWB/Club Cab)
108.3"/122.9"

36.9'/41.3'

Rack-and-pinion
not available

P205/75R15



PC Tunes

EVER WISH your PC could tune in your favorite music radio stations? Some newer multimedia PCs can do it, but you can easily add the capability to almost any Windows PC with Minolta's (201-825-4000) PC FM receiver. The small, \$50 adapter plugs into a PC's 25-pin serial port (you can use an included adapter cable for nine-pin ports) and relays its audio to your sound card so you can listen through your PC speakers. <http://www.minolta.com>

A Cut Above

SKIL IS RIGGING its circular saws for do-it-yourselfers with features the pros like. Saw depth, for example, is easy to adjust and is highly visible on the rear of the blade guard. High-power models have a clever and safe way to lift the blade guard—leaving both hands in place, you simply depress a lever with your thumb. The saws range from \$50 to \$80 depending on the model. S-B Power Tool Co., 4300 W. Peterson Ave., Chicago IL 60646.



A Walk in the Forest

UNLIKE TREE-harvesting machinery with wheels or tanklike crawlers, the Plustech Forest Harvester causes little soil erosion and won't damage tree roots. The 10-ton machine gets around on six knee-jointed hydraulic legs with 22-inch rubber-booted circular feet. A joystick control allows precise maneuvering in cramped spaces. A band saw mounted on a 27-foot telescoping boom can fell trees up to 20 inches in diameter. Plustech Oy, Lokomonkatu 15, Box 306, 33101 Tampere, Finland.

Flat is Beautiful

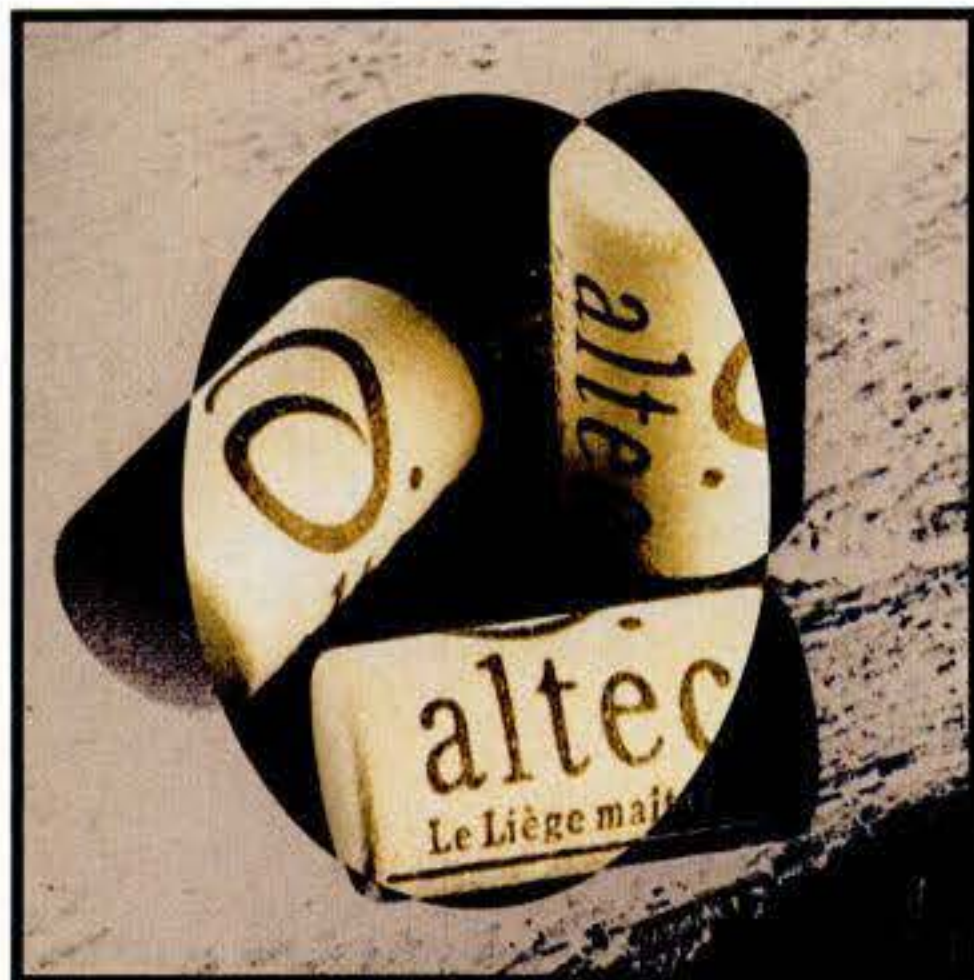
EVEN SO-CALLED "flat" CRT monitors typically have slightly recessed corners that can distort images. But Panasonic's (800-742-8086) PanaFlat PF70 is a truly flat display, with vibrant colors and no apparent distortion at its edges, even when viewed from many angles. The 17-inch monitor supports resolutions up to 1,600 by 1,280 pixels, and employs Windows' Plug & Play system for easy setup. It sells for \$999. <http://www.panasonic.com>



Detachable Digital

MINOLTA'S NEW Dimage V looks a lot like other digital cameras—until you pull off its lens. The rotating, detachable lens is tethered by a thin, one-meter (3.3-foot) cable, and the color LCD viewfinder displays your movements so that you can get exactly the right angle. A macro function lets you zoom in as close as two inches, and an optional headband lens holder opens up all kinds of photo possibilities. Resolution is standard VGA (640 by 480 pixels). It's expected to cost about \$700 to \$800. <http://www.minolta.com>





Composite Corks

NO MORE BITS of cork floating in your chardonnay. Sabaté, a leading manufacturer of cork stoppers, has developed a composite corking material that never decomposes. Called Altec, the material is composed of pure cork that is crushed and sorted for bits no bigger than a millimeter, and then bonded with polyurethane to other synthetic materials for elasticity. The corks are in use in France and will soon start appearing in the United States.

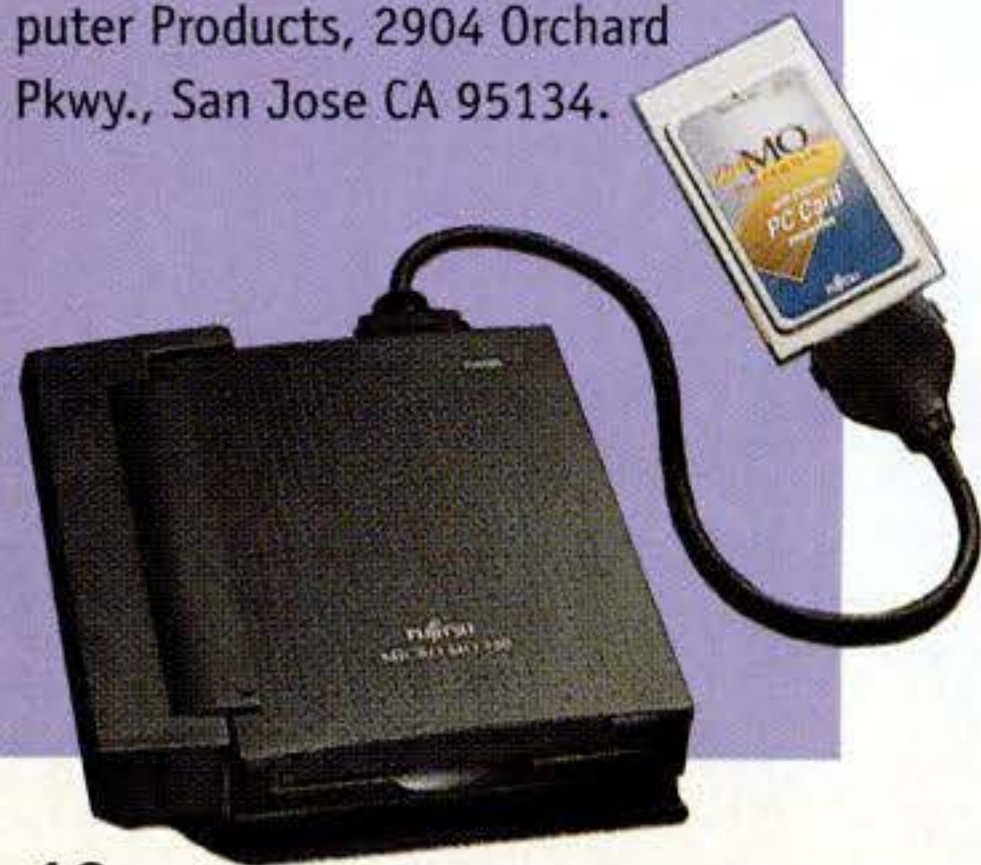


Race a Stock Car

COMING TO A MALL near you: a racing simulator that pits you against the sport's top drivers. Climb into a full-size Pontiac Grand Prix on a motion platform, and you're off. The car has realistic steering, pedals, and controls. The windshield is the visual display. The platform provides road noise and latitudinal G forces. Mariah Vision3 Entertainment LLC, 898 Airport Rd., Glen Burnie MD 21061; <http://www.MariahVision3.com>

Mobile Storage

FUJITSU'S DYNAMO 230 Portable drive is the first battery-powered magneto-optical storage device. Weighing a mere pound, this peripheral connects via a PC Card slot, not through the less universal SCSI port or slower parallel port. Price: \$500. Fujitsu Computer Products, 2904 Orchard Pkwy., San Jose CA 95134.



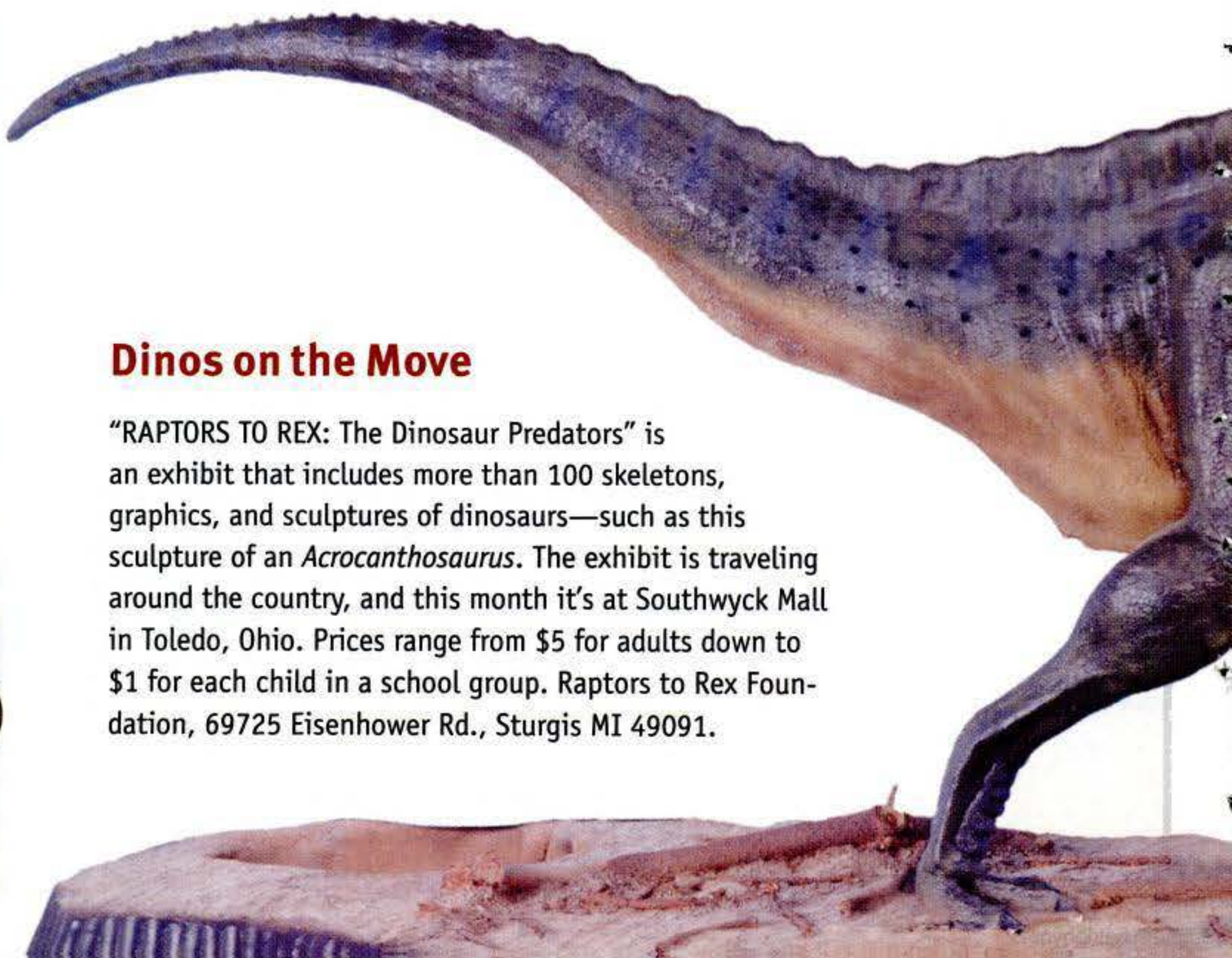
Computer-Compatible Camcorder

HITACHI'S MPEG camcorder makes transferring audio, video, and still images to a computer easier than ever: The camcorder's removable 260MB PC Card drive plugs directly into a notebook computer. Or, plug the palm-size camcorder directly into a TV. Each PC Card holds about 20 minutes of full-motion MPEG video or 3,000 JPEG-format still images at 352-by-240 resolution. Other features include a 3x optical/2x digital zoom lens that rotates 180 degrees and a 1.8-inch LCD screen/viewfinder. Price: about \$2,000 to \$2,500 in Japan.



Dinos on the Move

"RAPTORS TO REX: The Dinosaur Predators" is an exhibit that includes more than 100 skeletons, graphics, and sculptures of dinosaurs—such as this sculpture of an *Acrocanthosaurus*. The exhibit is traveling around the country, and this month it's at Southwyck Mall in Toledo, Ohio. Prices range from \$5 for adults down to \$1 for each child in a school group. Raptors to Rex Foundation, 69725 Eisenhower Rd., Sturgis MI 49091.





Tracking the Buzz

BEEES AND OTHER pollinators are disappearing in distressing numbers worldwide, so British researchers are experimenting with a harmless way to track the insects and gather information that could help preserve them. A radar tracking system emits a signal; an antenna weighing only three milligrams that's affixed to a bee reradiates the frequency, so the insect's travel can be monitored. Institute of Arable Crops Research-Rothamsted, Harpenden, Hertfordshire, AL5 2JQ, England.

Catch the Wave

THIS HIGH-SPEED V.34 modem gives net surfing a colorful twist: You customize your modem with skin-tight covers, called "surfsuits," available in Citrus Lemon, Tangerine Dream, Lagoon (green), and Purple Royale. Data compression is included, as are a Netscape browser and software for voice, data, and fax. The Surfer should be available in the United States later this year for about \$220. Psion Dacom plc, Dacom House, Presley Way, Crownhill, Milton Keynes MK8 OEF, England.



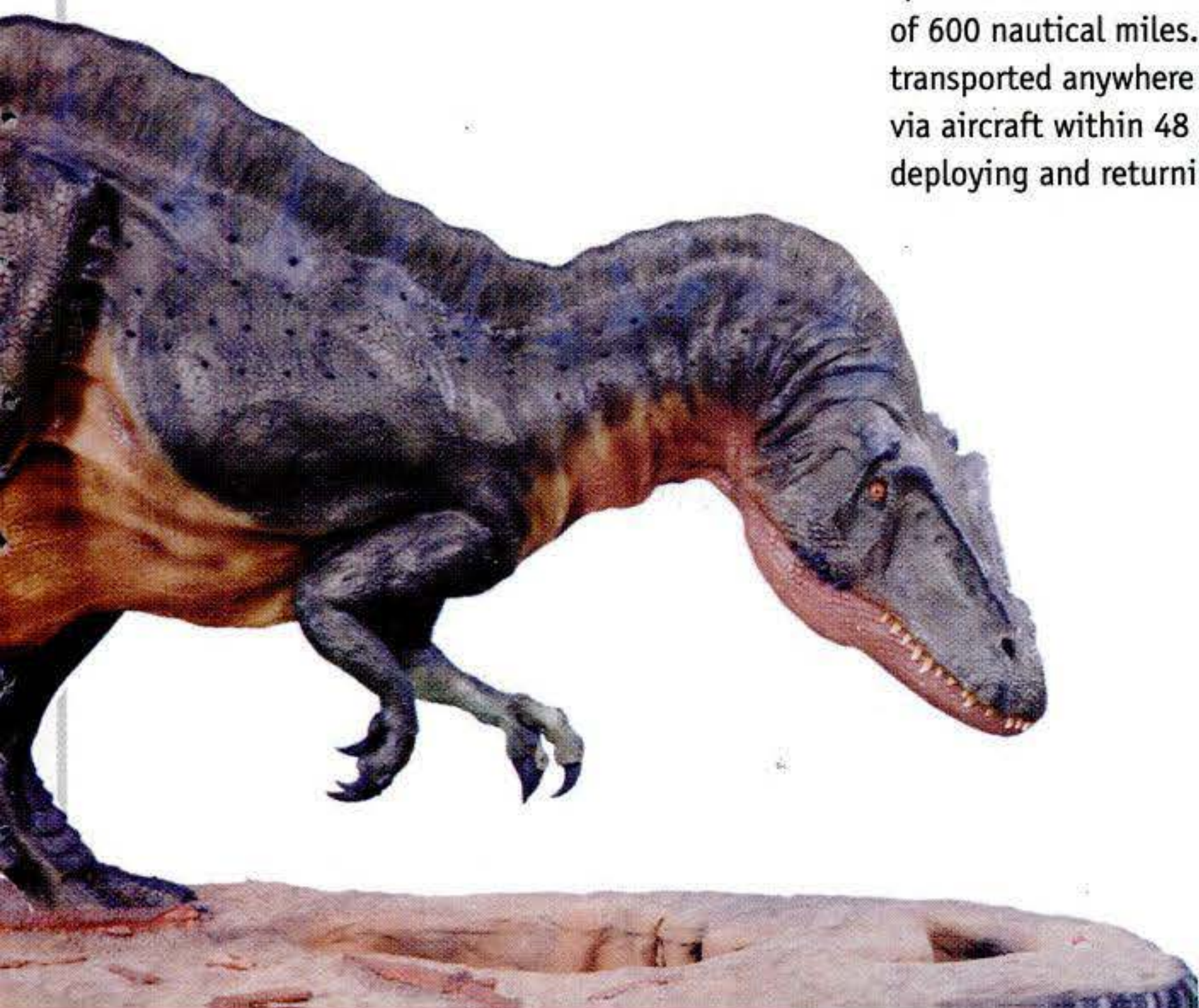
High-Speed Stealth

THE U.S. NAVY'S Mark V SOC—Special Operations Craft—is specially configured for covert operations. The hull design is nearly invisible to radar and the placement of the hydrojet drive system eliminates the telltale water spray inherent in other high-speed designs. The craft has a top speed of 50 knots and a range of 600 nautical miles. It can be transported anywhere in the world via aircraft within 48 hours for deploying and returning troops.



Peel 'n' Stick Lenses

THESE FLEXIBLE lenses transform any eyewear into reading glasses. The lenses are held in place by molecular attraction—like oil-change stickers on a windshield—so they peel off readily for transfer to different glasses. Currently available in nine strength levels, Optx 20/20 lenses cost about \$25 and are for normal eyewear; MagnOptx lenses, at \$30, are designed for use on safety glasses. Neoptx, 2205 152nd Ave. NE, Redmond WA 98052; 800-344-2020; <http://www.neoptx.com>



NEWSFRONTS

AUTOMOTIVE

EDITED BY DAN McCOSH

FIRST DRIVE

Honda's Light, Bright CRV

BOUNCING DOWN a back road on the Hawaiian island of Lanai in Honda's new CRV sport-utility vehicle, you quickly notice you aren't really bouncing all that much. It's the first sign that Honda isn't merely joining the crowd with this new sport Ute—the first to come directly from the drawing boards of this innovative Japanese automaker.

The CRV's smooth ride on rough trails is due to the fully independent upper and lower A-arm suspension, which is a long-travel version of the suspension on Honda sedans. The quiet, stiff body structure is a unit body instead of the body-on-frame construction popular with sport-utility-vehicle aficionados. Honda's combination of features is unique, and several other manufacturers are expected to follow in short order.

This type of construction promises a carlike sport utility, with ride, fuel economy, and highway handling that are superior to conventional SUV design—and off-road capabilities that are inferior. These generalizations hold true for the CRV, but a few important and unusual characteristics stand out in its design.

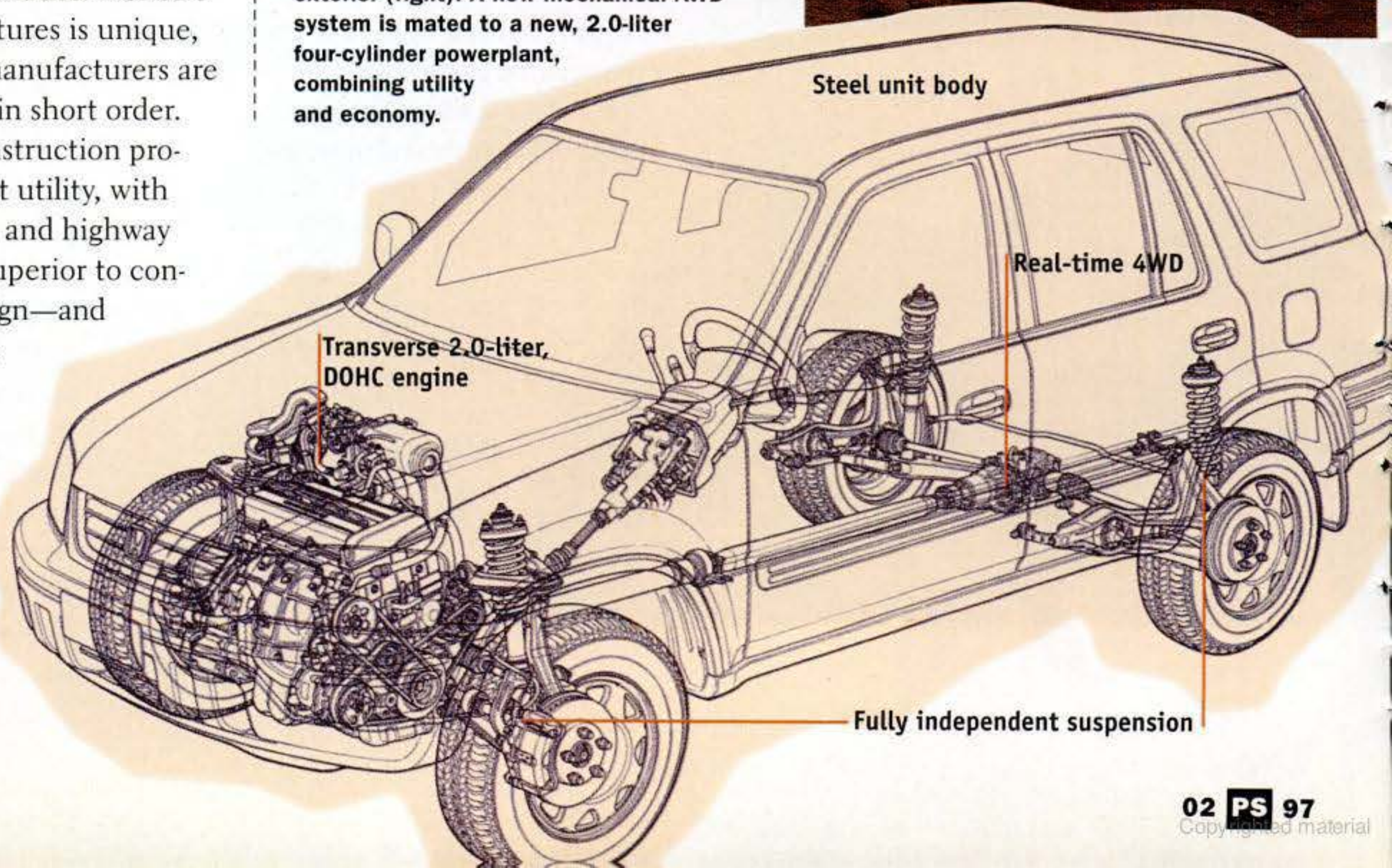
The CRV package is light (3,124 pounds) and roomy, with a smallish 103.2-inch wheelbase. It's a high-visibility driving environment, with lots of rear-seat legroom and a low sill height that makes climbing aboard easy. Interior features include a tiny, folding serving table between the front seats. In the rear, a picnic table hides underneath the rear carpeting, behind the 50-50 split fold-down seats. It's a package with unexpected finesse in ride, roominess, and handling, considering the CRV's compact dimensions and base price of less than \$20,000, including air conditioning and four-wheel drive.

The new 2.0-liter, four-cylinder aluminum engine generates 126 horsepower—adequate for the weight, but it's no stump-puller. The all-wheel-drive system includes a new mechanical clutch that is activated by the speed difference that occurs when the front wheels slip. The system lacks a low range, which means that descending steep grades will demand constant riding of the brakes. Ground clearance is good, but the exhaust system tends to clip rocks on the crown of the road.

Honda has designed an SUV for those who don't need or perhaps don't even like "real" sport utilities. It's a people and picnic hauler, good for snowy roads, but not dirt ones.—D.M.



A roomy interior (above) belies the compact exterior (right). A new mechanical AWD system is mated to a new, 2.0-liter four-cylinder powerplant, combining utility and economy.



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SAFETY

Softer Airbags Coming

SPURRED BY considerable controversy, the National Highway Traffic Safety Administration (NHTSA) has proposed a series of steps aimed at making airbags safer for children and smaller adults.

Airbags have been blamed in the deaths of about 50 people in low-

speed crashes since 1993, including a disproportionate number of children and short adults. The deaths represent a very small percentage of accidents in which airbags have deployed, but such deaths are expected to mount as the number of cars with airbags increases.

Proposed changes include warning labels advising that small children ride in the back seat in all cars equipped with airbags, and a reduc-

tion in the speed at which airbags deploy. Currently, airbags in U.S. cars are designed to deploy quickly enough to protect an unbelted adult, which generates more force than does the speed required to aid an occupant wearing a seat belt; at such a speed, an airbag hitting a child or adult too close to the bag could cause fatal injuries. The NHTSA also plans to allow car owners to have the airbags disconnected, a practice that currently is illegal except in some pickups that have a factory-installed "kill" switch that resets the system when the engine is restarted.

Other airbag proposals require new technology that will sense where occupants are seated, whether they're using the seat belts, and how much each occupant weighs. Sensors that rely on infrared readings or seat pressure are under development.—D.M.

PREVIEW DRIVE

Montero Sport Makes the Grade

MONTERO HAS a little brother, but the Montero Sport, Mitsubishi's slightly downsized five-passenger vehicle, is no slouch, on-road or off. During two days of driving on Arizona's mountain roads and desert trails, the four-wheel-drive Montero Sport was nimble, powerful, and even comfortable, taking creeks and concrete with equal ease.

Three four-door Montero Sport versions are offered. The entry-level ES is citified, with a 2WD powertrain and a 4-cylinder, 134-horsepower, 2.4-liter engine; a five-speed manual transmission is standard. Upscale models offer a 173-hp, 3.0-liter engine with either 2WD or 4WD, and a choice of automatic or manual transmissions. Other options include leather seats, upgraded sound sys-

tems, and a variety of other niceties, such as an unusual combination compass/outside air thermometer.

On the road or on the trail, the Montero Sport proves that it's a match for the competition. With the transfer case in the 2WD version, the ride is smooth. Visibility is excellent, with sightlines that are considerably higher than the average traffic. The Montero Sport with 4WD doesn't hesitate at mud (and presumably snow), and grips both upslope and downslope trails with easy security. And on the steepest and rockiest trails, the 4WD-low setting nearly turns the Montero Sport into a robot—it crawls steadily up or down, giving the humans inside time to monitor the terrain.

Sticker prices on the Montero Sport begin at \$17,700. A fully loaded Montero Sport XLS will go out the door at nearly \$33,000.—Jim Schefter



The Montero Sport is a midpriced sport-utility vehicle with nimbleness, power, and comfort.

ENGINES

Toyota's Lean Burner

TOYOTA SAYS IT has completed development of a new direct-injection, lean-burning gasoline engine and will install it in a production car this year in Japan.

Toyota claims fuel economy is 30 percent better than with an equivalent conventional two-liter engine, with a 10 percent improvement in torque and better throttle response. The fuel economy is in the range of a conventional passenger-car diesel, only slightly less than that of a direct-injection diesel, which burns fuel with a heat content higher than gasoline.

The direct-injection system sprays a lean fuel mixture directly into the cylinders, close to the spark plug. This differs from today's most common fuel-injection systems, which inject the fuel into the intake manifold.—D.M.

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For more information visit www.chevrolet.com or call 1-800-950-2438.

CHEVY S-10 LIKE A ROCK



*Excludes other GM products. Driver-side jumpseat deleted with third door. ©1996 GM Corp. Buckle up, America!

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PREVIEW DRIVE

Infiniti's Sporty SUV

A LUXURY SPORT-utility vehicle from Infiniti delivers all the comfort you might expect, but what separates the new QX4 from the rest of the black-tie-and-tuxedo pack is an innovative four-

Infiniti's new QX4 offers a unique all-wheel-drive system that engages automatically.



wheel-drive system adapted from an all-wheel-drive sports car.

Called the All-Mode 4WD system, this new electro-hydraulic method is borrowed from the Nissan Skyline, available only in Japan. The All-Mode system can vary the torque split between the front and rear wheels in any combination, from zero in the front and 100 percent

in the rear, to 50 percent front and rear.

Once you select All-Mode, the system kicks in automatically when it detects the throttle opening, when accelerating from a standstill, or when it senses wheel slippage. Otherwise, all power is sent to the rear wheels. All-Mode proved very effective when cornering in a test drive, particularly when driving over intermittent patches of ice. Under slippery conditions, it was easier to keep the vehicle moving in the direction we wanted to go.

All-Mode works well for the driver who doesn't want to think about 4WD options. A manual high/low lever overrides the electronics for off-roading. There is also a lock mode that keeps the torque split in a 50/50 position. Standard 2WD can also be selected. The base price on the QX4 is \$36,045.—*Frank Vizard*

ALTERNATIVE FUELS

A Clean Machine

A NATURAL-gas-powered Civic GX sedan, billed by Honda as "the cleanest vehicle ever made with an internal combustion engine," will make its first appearance this fall.

There is a hitch: This natural-gas Civic will cost \$4,500 more than its standard LX counterpart. However, the emissions of the GX are so low that they are nearly unmeasurable," says Honda research vice president Ben Knight.

Such a level is made possible by Honda's efficient VTEC engine design; a higher 12.5:1 compression ratio to capitalize on natural gas' higher octane; precise fuel management; dual catalytic converters; and, of course, the cleaner-burning properties of natural gas. This Civic's driving range is a respectable 305 to 340 miles per fill-up.—*Ron Cogan*

ENGINES

Chrysler Beefs Up

WHEN CHRYSLER launches its all-new 1998 LH models, the cars will feature a line of aluminum V6 engines, which is clearly the most dramatic single-year change ever in Chrysler powertrains.

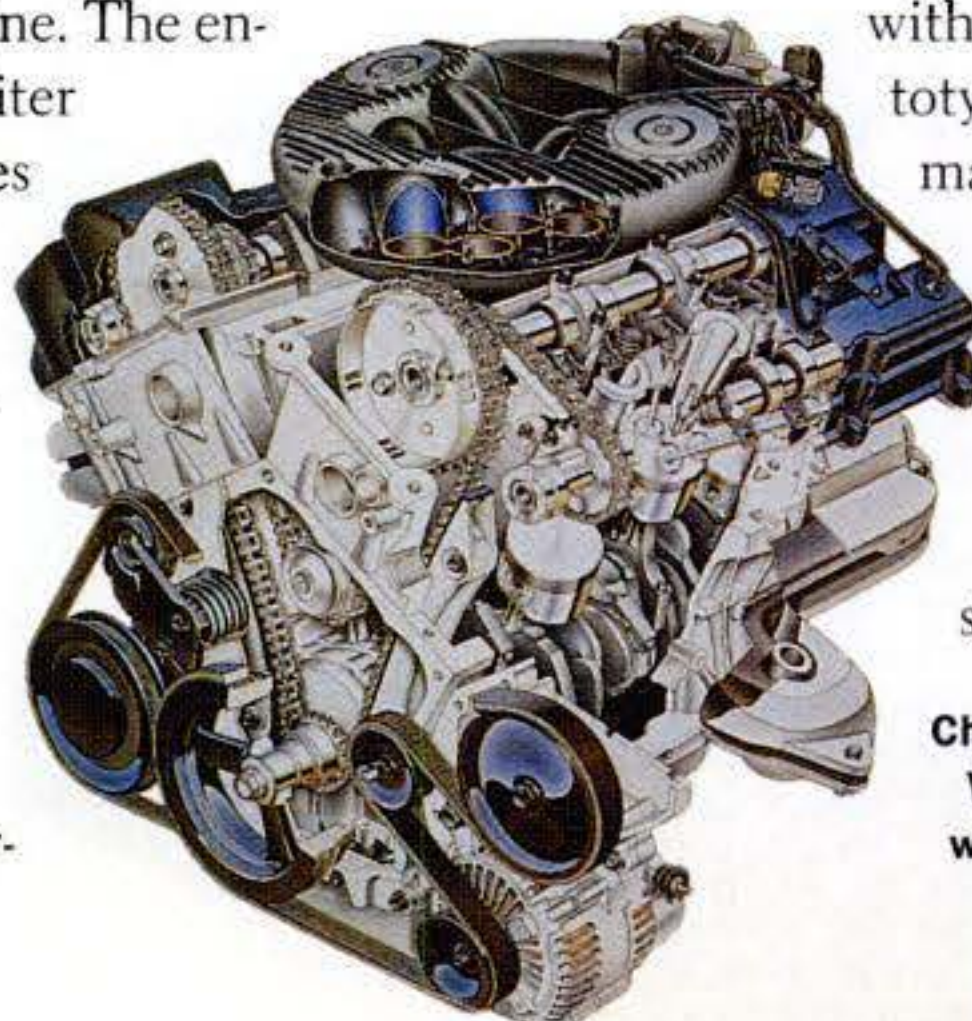
The revamped engine lineup will power a new range of mid- and full-size Chrysler products later this year. Chrysler claims that the new lineup has the highest power for a given displacement of any comparable production engine. The engines include a 2.7-liter model that produces 188 horsepower, a 3.2-liter, 200 horsepower engine, and a 3.5-liter version that puts out 250 horsepower. Still, fuel economy is expected to be improved by 10 per-

cent, with hydro-carbon emissions reduced by about 30 percent. Chrysler says the engines are capable of meeting California's low-emission standards by the year 2000.

All are 24-valve, SOHC engines with cast aluminum blocks. The ignition system uses an individual coil on each spark plug. Structural details add to the stiffness and reduce noise, Chrysler says. Main bearings are secured with six bolts, and the transmission case is reinforced.

The different displacements are modular, and share most major components. The design was developed with a new "rapid prototyping system" that makes a casting mold from a model built with layers of paper, stacked to duplicate the finished casting shape.—*D.M.*

Chrysler's 1998 2.7-liter V6 shares components with two other engines.



Happy Birthday CDHQ!

ROCK IN A HARD PLACE

Nine Inch Nails <i>The Downward Spiral</i> (TVT/Interscope) ▲	47•6739
Tom Petty & The Heartbreakers <i>Greatest Hits</i> (MCA)	47•4411
Bryan Adams <i>So Far So Good</i> (A&M)	46•7738
Stone Temple Pilots <i>Purple</i> (Atlantic)	46•5963
R.E.M. <i>Automatic For The People</i> (Warner Bros.)	44•8522
ZZ Top <i>Greatest Hits</i> (Warner Bros.)	43•8010
U2 <i>Achtung Baby</i> (Island)	43•1213
Pat Benatar <i>Best Shots</i> (Chrysalis)	40•1646
Type O Negative <i>October Rust</i> (Roadrunner)	16•5977
Joe Jackson <i>Greatest Hits</i> (A&M)	15•6802
Pantera <i>The Great Southern Trendkill</i> (eastwest) ▲	15•5713
Schoolhouse Rock! Rocks <i>Various Artists</i> (Lava/Atlantic)	15•1373
Gin Blossoms <i>Congratulations I'm Sorry</i> (A&M)	14•8171
Bonnie Raitt <i>Road Tested</i> (Capitol)	14•2745/39•2746
Melissa Etheridge <i>Your Little Secret</i> (Island)	14•0954
Pretenders <i>Isle Of View</i> (Warner Bros.)	13•9592
Green Day <i>Insomniac</i> (Reprise) ▲	13•9477
Red Hot Chili Peppers <i>One Hot Minute</i> (Warner Bros.) ▲	13•6804
AC/DC <i>Ballbreaker</i> (eastwest)	13•5830
Everclear <i>Sparkle And Fade</i> (Capitol)	13•0070
Billy Squier <i>Greatest Hits</i> (Capitol)	12•2887
Collective Soul (Atlantic)	12•2192
Goo Goo Dolls <i>A Boy Named Goo</i> (Warner Bros.)	12•1178
Van Halen <i>Balance</i> (Warner Bros.)	11•0866
Bon Jovi <i>Greatest Hits: Crossroad</i> (Mercury)	11•0395
Jimmy Page & Robert Plant <i>No Quarter</i> (Atlantic)	10•8977
"Pulp Fiction" <i>Original Soundtrack</i> (MCA) ▲	10•7151
R.E.M. <i>Monster</i> (Warner Bros.)	10•3929
Blues Traveler <i>Four</i> (A&M)	10•2699
Kiss <i>Unplugged</i> (Mercury)	15•2173

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NO MORE."

CUTTIN' A RUG

KC & The Sunshine Band <i>The Best Of...</i> (Rhino)	41•3419
Hits From The Heart II <i>Various Artists</i> (Real Gone)	16•7361
CeCe Peniston <i>I'm Movin' On</i> (A&M)	16•5670
Donna Lewis <i>Now In A Minute</i> (Atlantic)	16•5308
Robert Miles <i>Dreamland</i> (Arista)	15•8915
Casablanca Records <i>Various Artists</i> (Casablanca)	15•4062
2 Unlimited <i>Hits Unlimited</i> (Radikal/Critique)	15•0060
"Saturday Night Fever" <i>Original Soundtrack</i> (Polydor)	14•8551
La Bouche <i>Sweet Dreams</i> (RCA)	14•7546
Ace Of Base <i>The Bridge</i> (Arista)	13•9113
Real McCoy <i>Another Night</i> (Arista)	11•3662

INCLUDES DONNA SUMMER,
THE VILLAGE PEOPLE, AND
GIORGIO MORODER



Tracy Chapman
New Beginning
(Elektra)
14•2828



The Wallflowers
Bringing Down The Horse
(Interscope)
16•3477



Blackstreet
Another Level
(Interscope)
16•5688



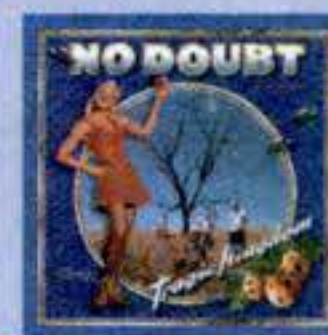
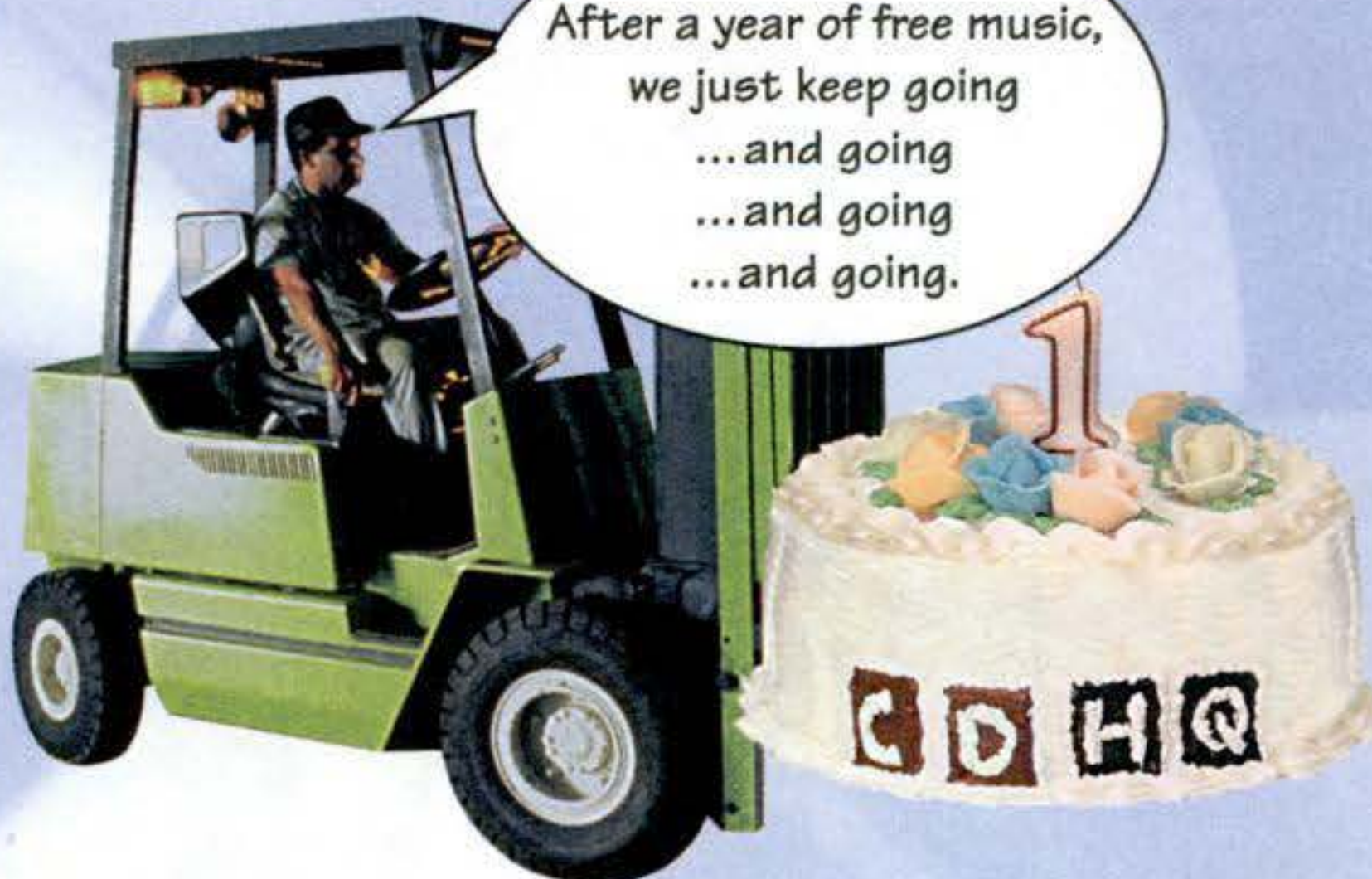
The Jerky Boys
The Jerky Boys 3
(Mercury)
16•4574



Cake
Fashion Nugget
(Capricorn)
16•6074



Bush
Sixteen Stone
(Trauma Records)
11•8885



No Doubt
Tragic Kingdom
(Trauma Records)
16•3436



311
(Capricorn) ▲
13•5335



The Dave Matthews Band
Crash (RCA)
15•6703



Alanis Morissette
Jagged Little Pill
(Maverick/Reprise) ▲
13•1623

THE ADULT ALTERNATIVES

Hootie & The Blowfish <i>Cracked Rear View</i> (Atlantic)	48•7553
Seal (1994) (Sire/Warner Bros.)	48•4741
Live <i>Throwing Copper</i> (Radioactive) ▲	47•8362
Sheryl Crow <i>Tuesday Night Music Club</i> (A&M)	47•6531
Violent Femmes <i>Add It Up</i> (1981-1993) (Reprise/Slash)	46•6656
Talking Heads <i>Stop Making Sense</i> (Sire)	32•9938
Suzanne Vega <i>Nine Objects Of Desire</i> (A&M)	16•5951
Catherine Wheel <i>Like Cats And Dogs</i> (Mercury)	16•4566
Tori Amos <i>Hey Jupiter</i> (Atlantic)	16•4228
Various Dogs—Live From The Pound <i>The Beatles</i> (A Parody) (Dove Audio)	16•3295
Crowded House <i>The Very Best Of...</i> (Capitol)	16•1778
Nada Surf <i>High/Low</i> (Elektra)	15•9665
The Cranberries <i>To The Faithful Departed</i> (Island)	15•6992
Jann Arden <i>Living Under June</i> (A&M)	15•5903
The Cure <i>Wild Mood Swings</i> (Elektra)	15•5705
Tracy Bonham <i>The Burdens Of Being Upright</i> (Island)	15•2157
The Refreshments <i>Fizzy Fuzzy Big & Buzzy</i> (Mercury)	15•0540
Adam Sandler <i>What The Hell Happened To Me</i> (Warner Bros.) ▲	14•7512
Spacehog <i>Resident Alien</i> (Sire/Elektra) ▲	14•5367
Poe Hello (Modern) ▲	14•0558
Eurythmics <i>Greatest Hits</i> (Arista)	14•0160
"Friends" (Music From The TV Series) <i>Various Artists</i> (Reprise/Sire)	13•9279
Jewel <i>Pieces Of You</i> (Atlantic)	13•7463
Deep Blue Something <i>Home</i> (Interscope)	13•7273
Natalie Merchant <i>Tigerlily</i> (Elektra)	13•0971
Dishwalla <i>Pet Your Friends</i> (A&M)	12•9577
Joan Osborne <i>Relish</i> (Blue Gorilla/Mercury)	12•6110
Elvis Costello & The Attractions <i>The Very Best Of</i> (Rykodisc)	11•8968

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Grease Original Soundtrack (MCA)	42-4721
David Bowie Changesbowie (Rykodisc)	41-2247
The John Lennon Collection (Capitol)	40-5308
Grateful Dead Skeletons From The Closet (Warner Bros.)	37-8406
Fleetwood Mac Greatest Hits (Warner Bros.)	37-5782
Eagles Greatest Hits, Vol. 2 (Asylum)	31-7768
The Best Of Blondie (Chrysalis)	31-1811
Creedence Clearwater Revival Chronicle-20 Greatest Hits (Fantasy)	30-8049
America's Greatest Hits (Warner Bros.)	29-1385
James Taylor's Greatest Hits (Warner Bros.)	29-1302
The Steve Miller Band Greatest Hits 1974-78 (Capitol)	29-0171
War The Best Of War...and More (Avenue Records)	15-8527
Jim Croce Photographs & Memories (Saja/Atlantic)	13-9006
Frank Zappa Best Of...Strictly Commercial (Rykodisc)	13-4452
Elvis Presley The Number One Hits (RCA)	12-5591
Eric Clapton The Cream Of Eric Clapton (Polydor)	12-1665
Neil Young Harvest (Reprise)	12-9189

TWANG TOWN

Alan Jackson Who I Am (Arista)	48-6233
Reba McEntire Starting Over (MCA Nashville)	16-8294
Mavericks Music For All Occasions (MCA Nashville)	16-8286
John Berry Faces (Capitol Nashville)	16-5738
Travis Tritt The Restless Kind (Warner Bros.)	16-4822
Mindy McCready Ten Thousand Angels (BNA Records)	15-5473
Toby Keith Blue Moon (A&M/Nashville)	15-3973
Bryan White Between Now & Forever (Asylum)	15-1357
Tracy Lawrence Time Marches On (Atlantic Nashville)	14-7082
Faith Hill It Matters To Me (Warner Bros.)	13-4908
John Michael Montgomery (Atlantic Nashville)	12-1467
Alison Krauss Now That I've Found You (Rounder)	12-0345
Shania Twain The Woman In Me (Mercury/Nashville)	11-9768
Trisha Yearwood Thinkin' About You (MCA/Nashville)	11-8703
Brooks & Dunn Waitin' On Sundown (Arista Nashville)	10-2277

TAKE IT EASY

ABBA Greatest Hits:Gold (Polydor)	45-8406
Kenny G Breathless (Arista)	44-8142
Tina Turner Simply The Best (Capitol)	43-3342
Bob Marley & The Wailers Legend (Tuff Gong/Island)	33-7857
UB40 Labour Of Love (A&M)	32-5472
Jimmy Buffett Banana Wind (MCA)	16-8278
David Sanborn Songs From The Night Before (Elektra)	16-5936
Natalie Cole Stardust (Elektra)	16-5928
"Phenomenon" Original Soundtrack (Reprise)	16-0689
Norman Brown Better Days Ahead (Mojazz)	15-9392
Air Supply Greatest Hits Live... (Giant)	15-9111
Gipsy Kings Tierra Gitana (Nonesuch)	15-8923
Lionel Richie Louder Than Words (Mercury)	15-4047
Enya The Memory Of Trees (Reprise)	14-3800
Madonna Something To Remember (Maverick/Sire/Warner)	13-9535
Bette Midler Bette Of Roses (Atlantic)	13-2191
Sting Fields Of Gold (A&M)	11-3555



Republica
(Deconstruction/
RCA)
16-5399



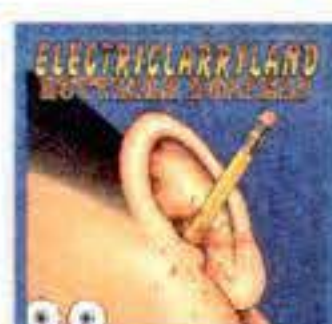
Tom Petty & The
Heartbreakers
Music From
"She's The One"
(Warner Bros.)
16-1828



Los Del Rio
Macarena Non Stop
(BMG U.S. Latin)
16-3840



Styx Greatest Hits:
Time Stands Still
(A&M)
13-6721



The Butthole
Surfers
Electric Larryland
(Capitol)
15-6042



Jeff Foxworthy
"Crank It Up-The
Music Album"
(Warner Bros.)
16-4806

DAGWOOD'S FAVORITE

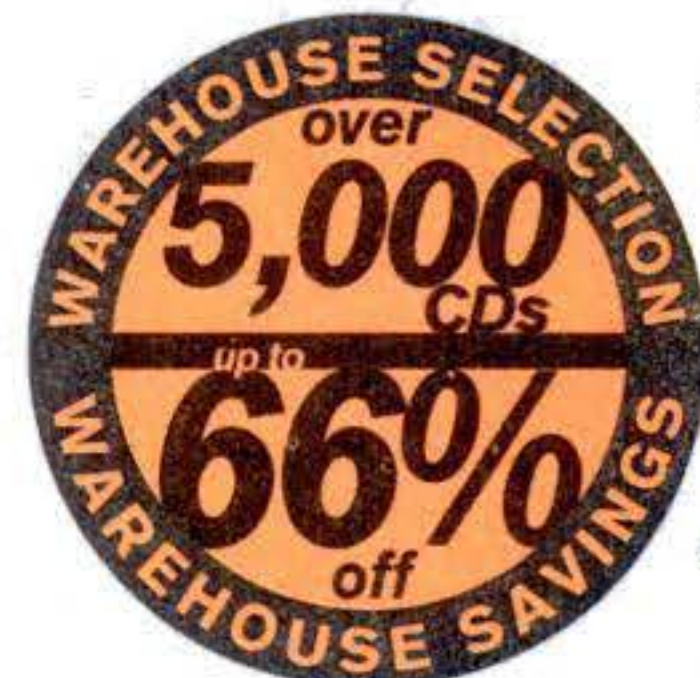


URBAN JAMZ

Salt-N-Pepa Very Necessary (Next Plateau/London)	46-7837
Janet Jackson Rhythm Nation 1814 (A&M)	38-8918
Beastie Boys Licensed To Ill (Capitol) ▲	35-1692
"Dangerous Minds" Original Soundtrack (MCA) ▲	16-8419
Outkast Aliens (LaFace) ▲	16-5449
Montell Jordan More To Tell (Def Jam)	16-4236
Aaliyah (Blackground Enter/AI)	16-2040
A Tribe Called Quest Beats, Rhymes And Life (Jive)	16-1711
Keith Sweat (Elektra)	15-9657
Toni Braxton Secrets (LaFace)	15-9202
SWV New Beginning (RCA)	15-5347
Quad City DJ's Get On Up And Dance (Quindra/Big Beat/AL) ▲	15-4252
The Isley Brothers Mission To Please (Island Black Music)	15-4138
Busta Rhymes The Coming (Elektra) ▲	15-1399
LL Cool J Mr. Smith (Def Jam/Mercury) ▲	14-3560
R. Kelly (Jive)	14-2711
"Waiting To Exhale" Original Soundtrack (Arista)	14-0962
Quincy Jones Q's Jook Joint (Warner Bros./Qwest)	13-9485
D'Angelo Brown Sugar (EMI) ▲	13-1714
Coolio It Takes A Thief (Tommy Boy) ▲	12-9627
Mary J. Blige My Life (Uptown/MCA)	11-3399
TLC CrazySexyCool (LaFace)	11-0650
Boyz II Men II (Motown)	10-2681

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Soft Cell Memorabilia (Mercury)	43-0447
Public Enemy It Takes A Nation Of Millions To Hold Us Back (Def Jam)	37-1833
The Nixons Foma (MCA)	16-8435
Fun Lovin' Criminals Come Find Yourself (EMI)	16-7247
Porno For Pyros Good Gods Urge (Warner Bros.)	15-5929
Stanford Prison Experiment The Gato Hunch (World Domination)	15-2447
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COMPUTERS & SOFTWARE

EDITED BY CHRIS O'MALLEY

HANDHELD PCs

Peeking Through Smaller Windows

HAS THE DEATH of the personal digital assistant been greatly exaggerated? Maybe so. The PDA is being reborn as a more practical, if less sensational, desktop PC helper.

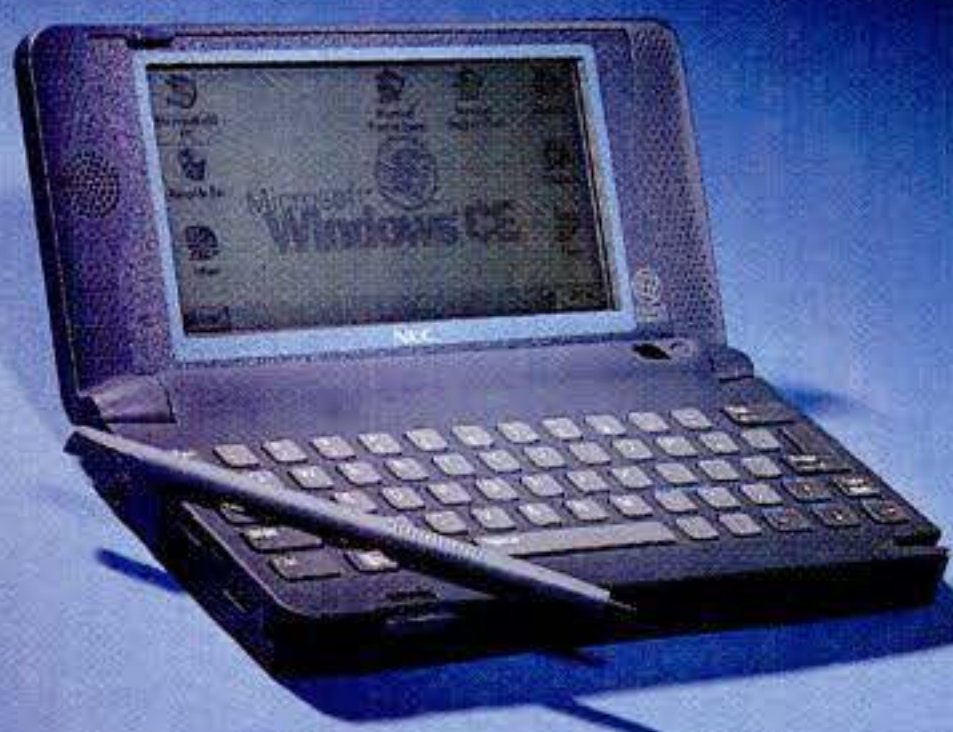
U.S. Robotics reignited the field with its Pilot, a \$300 device that can swap data with a desktop simply by putting the PDA in a stand that remains cabled to the PC. Now, Microsoft is hoping to pour gasoline on that spark with a special version of its Windows operating system, called

tiny laptop PCs. Most sell for \$300 to \$600.

Why run Windows on a PDA? For one thing, it makes the whole affair seem more familiar, and streamlined versions of popular Microsoft applications such as Word and Excel are included, which makes sharing documents easier. More than 30 software makers say they are writing programs for the WinCE system, too. For some, like Compaq, this is the first attempt at a handheld PC. Compaq's PC Companion has a touchscreen, a PC Card slot, and a two-way pager option for wireless e-mail. It runs for about 20 hours on two AA batteries. Using a modem shortens battery life, however.

Of course, small size and long battery life have their drawbacks. The displays on these PDAs are small and relatively dim, and the Chiclet-size keys and penlike pointer may test your patience.

Not everyone is doing Windows. In addition to the Pilot, other options include Apple's Newton and Sharp's Zaurus models—C.O.



Windows CE, for handheld PCs. Casio, Compaq, LG/Goldstar, Hewlett-Packard, NEC, and Philips are among the spate of manufacturers selling new WinCE based devices. All have the same rectangular shape, with clamshell lids and keyboards that make them resemble



NEC's Mobile Pro HPC (left) and Compaq's PC Companion are among the first handheld PCs to use Microsoft's Windows CE system.

WEB WATCH

Our monthly Web filter

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The Sporting News

www.sportingnews.com

For major league fans.

Architectural Dublin

www.nua.ie/ArchDub/

The Irish capital's building beauties.

Think Quest

www.advanced.org

Student science and tech projects.

Perseus

www.perseus.tufts.edu

Ancient Greece, with Romans to come.

Windows to the Universe

www.windows.umich.edu/

View the stars via pictures and movies.

Thunder Lizards

www.geocities.com/CapeCanaveral/6399/

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What is Forensic Science?

users.aol.com/murk/index.htm

Answers to that leading question.

An Introduction to Wildlife Diversity

www.oit.itd.umich.edu/project/ADW/

How zoologists categorize species.

Particle Adventure

pdg.lbl.gov/cpep/adventure.html

Atom anatomy 101.

Metamorphium

www.multimedia.belllabs.com

Chat with New Yorkers on a virtual subway.

—Suzanne Kantra Kirschner

BEYOND HERE

The Millennial Mess



BY GINA SMITH

IT'S SATURDAY, January 1, 2000. Do you know where your library books are? You'd better, because they're a century overdue. And that's not

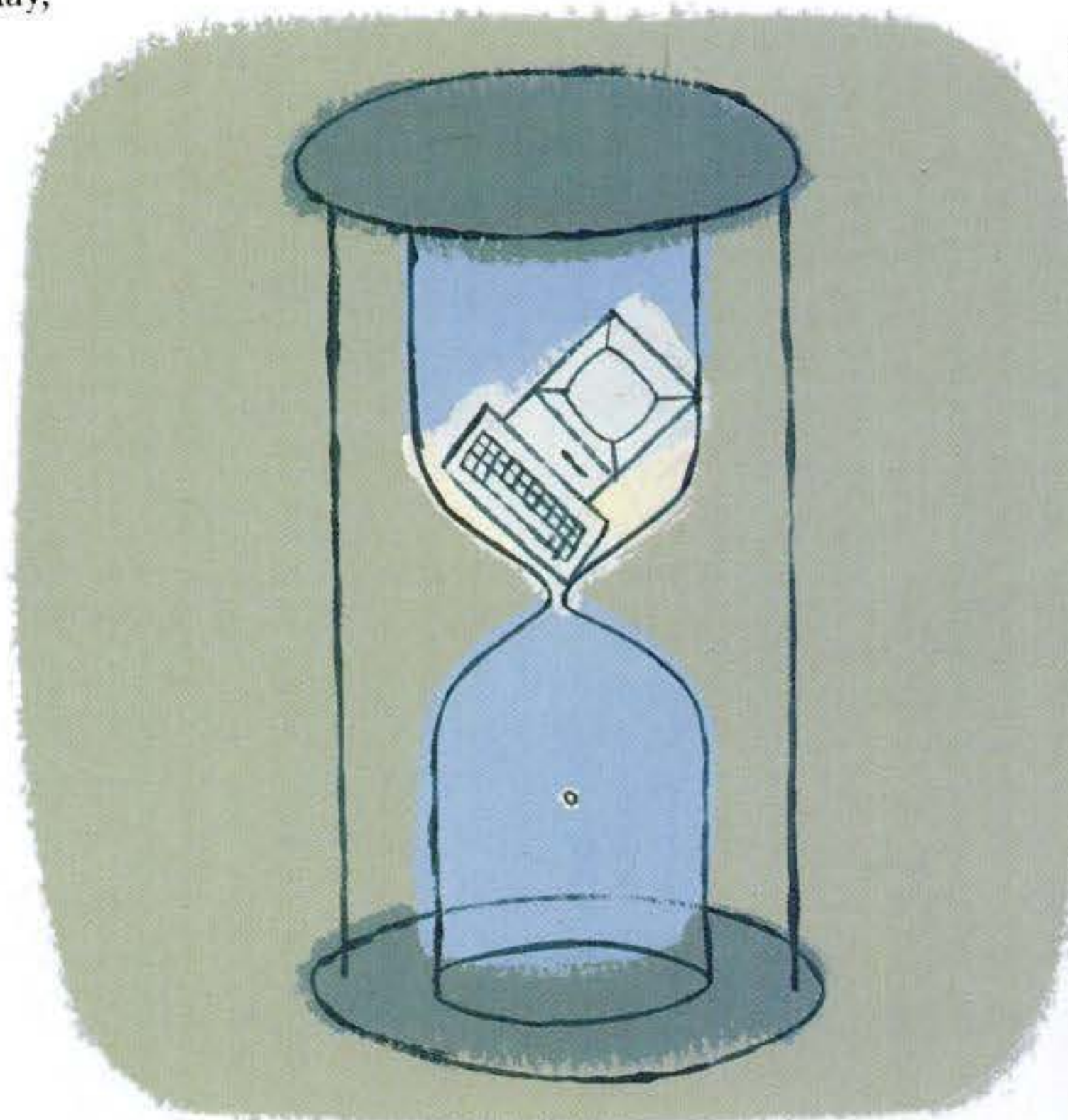
the worst of it. Come Monday, your driver's license, credit card, and insurance policies will be canceled. That phone call you made on New Year's Eve? It'll run you into the millions, as will the interest on the credit card you just lost. And it could take weeks or months to straighten it all out.

Odds are, you've heard of the Year 2000 bug. It's the problem resulting from the fact that most big-computer software created in the 1960s, '70s, and '80s records dates using only the last two digits of the year—as in 02/15/97. So, to many computers, the Year 2000 (01/01/00) will look like 1900, since the "19" is assumed. And every day thereafter could be construed as occurring 100 years earlier. It's a seemingly small glitch that could wreak havoc for millions of American consumers come the turn of the millennium.

Alarmist? Look at the numbers. Analysts say that as much as 30 percent of all American businesses won't have their computer software ready in time for the date change. That could spell big trouble, not only for consumers but for the businesses themselves. Snags, lawsuits, and the cost of last-minute fixes could end up driving some 20 percent of all

companies out of business altogether, according to one estimate.

You are probably wondering why the problem is so hard to fix. It isn't. It's just that there's so much to be fixed. Updating software to handle the new century is sometimes a matter of culling through millions of lines of code, and then finding and fixing every two-digit date reference. One mistake and the entire operation may be unsuccessful. If routine bug fixes are akin to finding



defective seats in a football stadium, the Year 2000 fix is more like repairing every wobbly chair in America.

The problem is unlikely to affect your PC in any significant way. Dates don't matter much in most PC programs, and many of the ones that do matter have been fixed already. Intuit says it has amended its Quicken checkbook program, for example, and Microsoft made changes to its Excel spreadsheet to handle new-millennium dates. You can generally expect the same of most PC accounting software. But the custom-fit software that runs larger computers is another, far more complicated, can of worms.

Big deal? It could be. Milk could get spilled, as the dates computers see on cartons make them appear to be too old for sale. Planes might automatically be grounded as airline systems mistakenly identify them as decades overdue for maintenance. Bank accounts could be frozen while the numbers are juggled. And don't even think about the government. The IRS has only recently started to fix its systems—and has a troubling history with technology. If the

IRS doesn't convert in time, the government could come to a standstill.

Even if a given company does manage to fix its software, a major problem remains: Doing business and exchanging data with even one firm that hasn't fixed its own systems could reinfect other systems with erroneous dates. It's no wonder CEOs have been silent on the subject. Lawyers, meanwhile, are salivating, and so are consulting companies that specialize in Year 2000 updating. JP Morgan has come out with a report of the 10 public firms that stand to benefit most. If you

play the market, I suggest you dig the report up.

And speaking of digging, at least one Year 2000 consultant I spoke to proposed taking your money out of the bank and burying it in the backyard. I wouldn't go that far. But it might be worth checking with your bank—and perhaps keeping a shovel handy.

Gina Smith appears regularly on "Good Morning America," and nightly as host of The Discovery Channel's "Cyberlife." Send comments to PSLetters@aol.com.

The Soul of the Next Machine

SOME 50 YEARS after the computer era started with ENIAC, the movers and shakers of the breakneck-paced world of computing are going to pause, momentarily at least, to consider what the next 50 could bring.

"The Internet is here. PCs are in homes. Now, many more people than nerds need to pay attention to which of the possible futures we want to pursue," says Bob Metcalf, who is chairing the Association for Computing Machinery's ACM97 conference, designed to shed some light on those futures. ACM97 will be held from March 1 through 5, and will be open to the public. Among the featured speakers are Nathan Myhrvold, the leading technology guru at Microsoft; Vinton Cerf, one of the Internet's pioneers, now at MCI; and Murray Gell-Mann, a Nobel Prize winner in physics. The conference is being underwritten by such industry heavyweights as Hewlett-Packard, Intel, and Microsoft.

POPULAR SCIENCE is also participating, as a cosponsor of the ACM Vision of the Future essay contest. Students in grades nine through 12 who submitted an essay on how computer technology will change our lives over the next 50 years will be judged on the creativity and excitement they have conveyed.

In addition to the conference, being held at the San Jose Convention Center, a World Wide Web site and book will chronicle the event. You can join the discussion on ACM's Web site by steering your browser to www.acm.org/acm97 after the conference. —*Mariette DiChristina*

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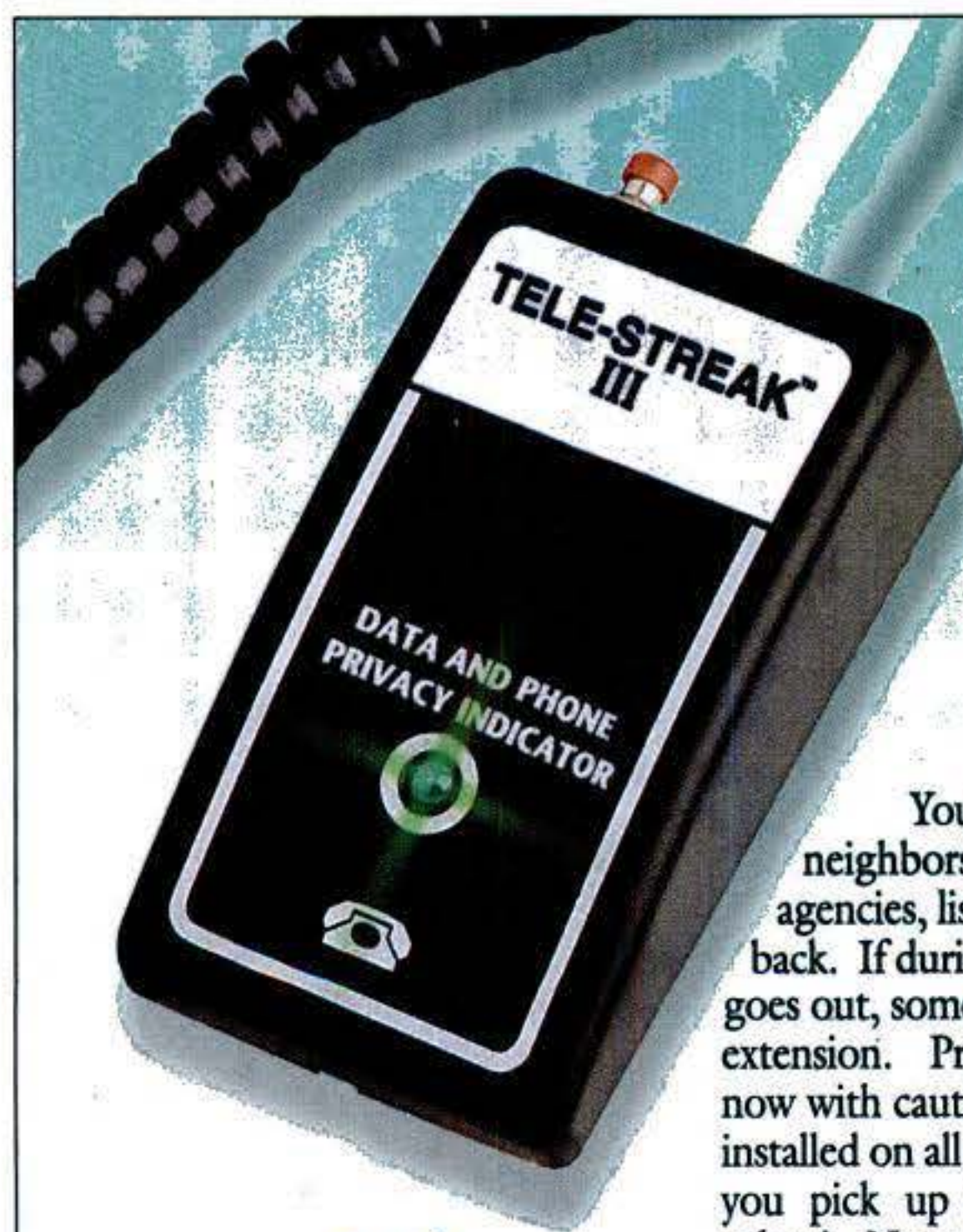
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HOME TECHNOLOGY

EDITED BY JUDITH ANNE GUNTHER

GAS FIREPLACES

Clean-Air Design Goes for the Glow

FOR MANY homeowners, the easiest way to add the cheer and warmth of a fire is to choose a vent-free gas fireplace. Since these natural-gas or propane units operate so hotly that few byproducts of combustion are produced, a chimney or vent to the outside isn't considered necessary. Instead, the exhaust is directed back into the room.

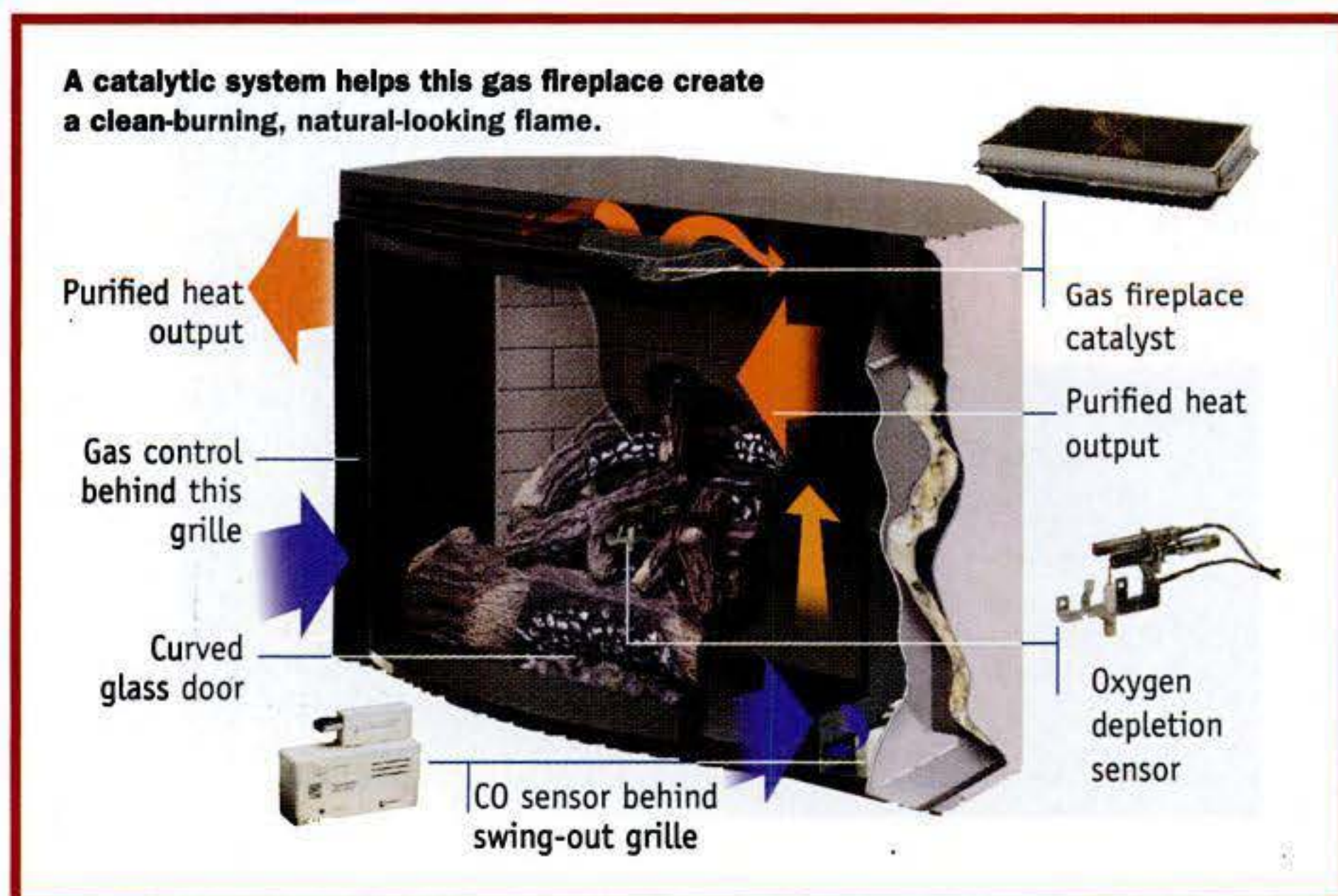
The problem is that the efficient flames are blue, like those on a gas range, and not the bright yellow flame of a traditional wood fire. Now, one company, Superior Fireplace Company of Fullerton, California, claims to have solved this problem by adding on an "exhaust scrubber" to cooler-burning gas fireplaces, removing combustion byproducts before the exhaust air is dumped back into the house. This system, the company says, helps produce a more natural-looking fire without requiring a vent.

Superior's PureHeat unit incorporates a catalytic system developed

by Corning. When exhaust air flows through the catalytic system, noble metals on a ceramic substrate aid the chemical conversion of carbon monoxide to carbon dioxide. The catalyst also limits the release of nitrogen dioxide, particulates, and other emissions. The system is similar to catalytic devices currently in use on woodstoves, except that this catalyst operates at temperatures of 500° F and higher, says senior engineer Samir Barudi, while woodstove catalysts are activated at temperatures of 1,000° F or higher.

Independent laboratory tests show PureHeat's carbon monoxide and nitrogen dioxide output are significantly below the industry standards for vent-free products. Still, Superior decided to include a carbon monoxide detector in the appliance, as well as an oxygen depletion sensor, a device that shuts the fireplace off when oxygen levels in the room drop to unsafe levels.

Available in both natural gas and propane models, the PureHeat fireplace sells for about \$2,200.—J.A.G.



PLUMBING

The Physics of Freezing Pipes

BURST WATER pipes are caused by the expansion of freezing ice against the walls of the pipe, right? Wrong.

In a remarkable series of laboratory and field experiments, researchers at the University of Illinois have demonstrated that the actual cause of damage to freezing water pipes isn't the force of the expanding ice on the pipe, but rather an extreme rise in water pressure downstream from the blockage. According to the study, the water pressure can rise in these situations from about 40 pounds psi to more than 4,000 pounds psi.

A typical scenario might go like this: A stretch of copper pipe is exposed to unusually cold temperatures, and ice begins to form on the pipe's inside walls. Since water volume expands by about 8 percent as it turns to ice, the ice formation eventually can completely block the water flow. Water upstream from the blockage is able to flow back to its source, such as the street connection. But the water downstream is trapped because the faucets are closed. As the ice continues to form and expand, pressures downstream from the blockage skyrocket. Because this entire section of pipe experiences the same elevated pressure, the failure can occur at any point, even within the heated space of the building.

Now that researchers better understand the problem, they have devised a simple, effective solution: a modified faucet washer that enables the faucet to leak a little under high pressure. This inexpensive device could eliminate much of the \$400 million per year of insurance claims now paid to homeowners for freeze-related plumbing damages.—Ned Nisson

TOXINS

The Uninvited Guest

IS YOUR HOUSE being invaded by invisible, subterranean substances? No, this isn't an X-Files plot. It's

something scarier—it's the subject of a recent study on the movement of groundwater toxins.

For years, various industries have used a solvent called trichloroethylene for the cleaning of equipment and other jobs. Over time, this sus-

pected carcinogen has migrated from industrial dump sites into groundwater. Now, researchers at Rutgers University and the Environmental and Occupational Health Sciences Institute in Piscataway, New Jersey, have constructed a mock basement to simulate the movement of trichloroethylene from groundwater, through soil, and into basements.

Researchers David Fischer and Christopher Uchirin filled a two-foot-long Plexiglas box with soil and "groundwater," and inserted a second, smaller box into the soil to represent the basement. They then varied the level of the water table, the concentration of trichloroethylene, the soil type, and the size of cracks in the "basement" floor, measuring contamination levels for each set of conditions.

Basements showed the greatest trichloroethylene concentrations when the water table was close to the basement floor, when the groundwater contained high levels of the chemical, and when the soil was permeable, as sandy soils are. "Soils with high organic materials absorb organic compounds," says Fischer, "so they tend to retard the movement of trichloroethylene." In addition, computer models showed that the air pressure within the basement played a role as well. Often, unbalanced ventilation in a house causes the basement to be under slightly negative pressure, he says, which pulls the gas into the house.

More research is needed to determine the effects of other potential factors, like the moisture content of the soil. And this study didn't attempt to determine how much trichloroethylene constitutes a health hazard. Remedies for contaminated basements might be as simple as increasing the ventilation—in effect, steadily flushing the house out with fresh air—or employing more complex strategies now used to combat another suspected basement menace, radon.—J.A.G

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SCIENCE & TECHNOLOGY

EDITED BY DAWN STOVER

THE PLANETS

Wet Weather on Jupiter

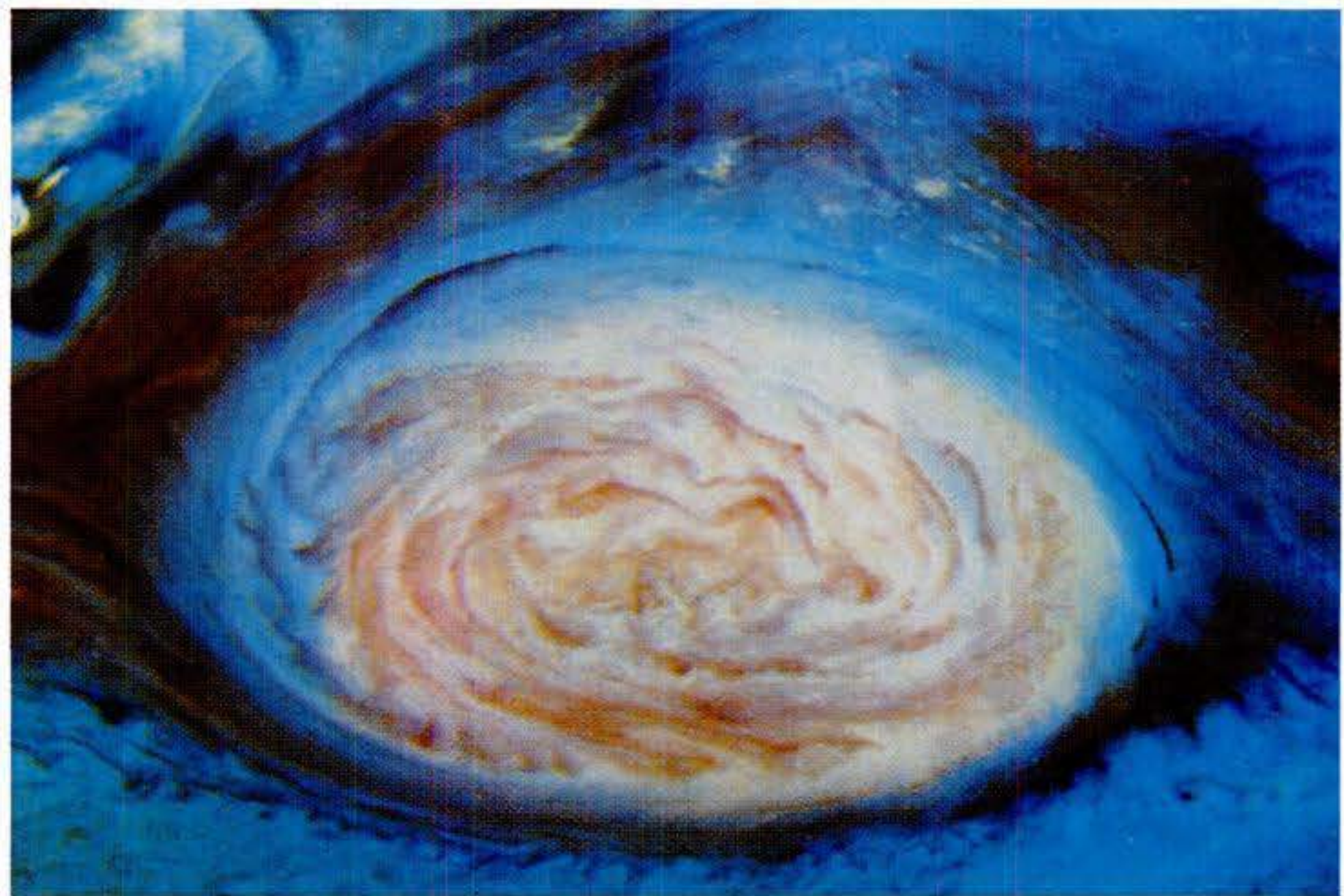
BEFORE THE Galileo orbiter visited Jupiter, scientists believed the planet might have violent thunderstorms, lightning, and rain. But when the orbiter's probe dropped into the Jovian atmosphere in December 1995, it found a dry area where water was 10 times more scarce than predicted. Which is the real Jupiter?

That's still an open question, but new images of Jupiter offer evidence that the giant planet may be wet after all, according to a team led by Andrew Ingersoll of the California Institute of Technology in Pasadena. The images were taken in near-infrared light, which is invisible to the naked eye. They show dozens of high-altitude thunderclouds northeast of the Great Red

Spot. While the clouds haven't been proven to contain water, they are high and change rapidly, much like Earth's thunderclouds. "Water is the

most likely cause," says Ingersoll.

Ingersoll and graduate student Adam Showman theorize that the dry, cloudless area Galileo's probe sampled may have been part of a huge downdraft that extends into Jupiter's interior. Similar downdrafts occur above Earth's deserts.—*Mariette DiChristina*



The white circles in this near-infrared image are the planet Jupiter's version of thunderclouds.

AVIATION

Megaplane Takes Wing

THE BOEING CORP. and Europe's Airbus consortium are preparing to offer bigger airplanes to the world's airlines. Now that talks on a joint project have broken down, Boeing is pushing a stretched version of the 747, and Airbus is designing an all-new aircraft, known as the A3XX.

Seating 550 passengers in the basic model, and 650 in a

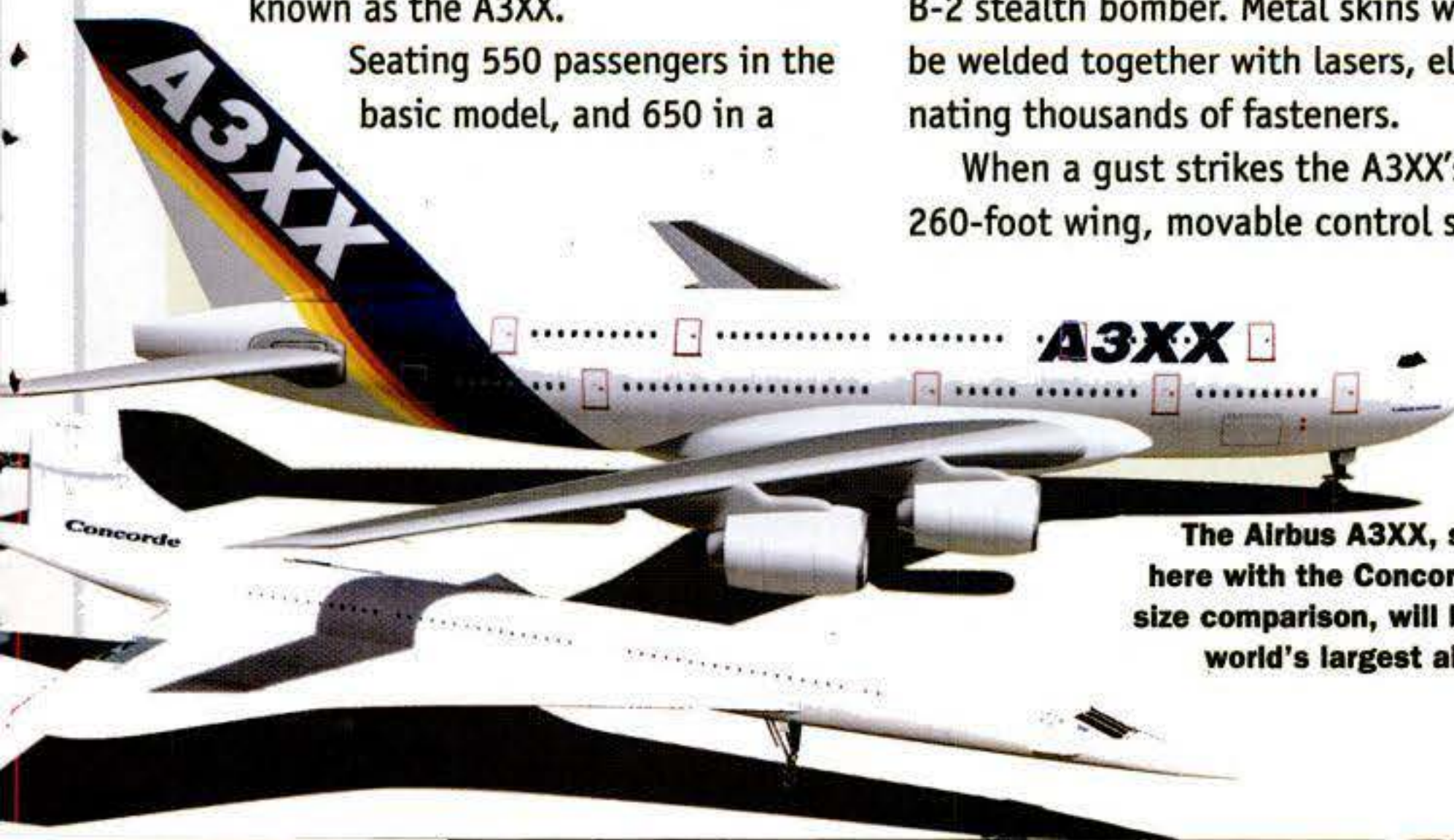
stretched version, the 1.2 million-pound A3XX will not only be the largest airplane in the world, but it will also be one of the most advanced. The outer wings and the horizontal stabilizer (as big as a smaller jet's wing) will be made of carbon-fiber composite materials, and will be the largest such structures on any aircraft except the B-2 stealth bomber. Metal skins will be welded together with lasers, eliminating thousands of fasteners.

When a gust strikes the A3XX's 260-foot wing, movable control sur-

faces will prevent it from flexing like a giant spring. This will make the ride smoother, and will save weight by reducing the load on the wing spars. A flexible-skinned flap will subtly change the wing's curvature to match the airplane's changing weight as it burns fuel on each journey.

The A3XX will carry up to 1,600 meals, filling more than 100 food and beverage carts. To make more room for passengers, Airbus plans to put the carts in the lower hold; automatic conveyors and elevators will deliver them to the two passenger decks. Airlines have asked Airbus to look at extra features ranging from lower-deck sleeper cabins to a children's playroom.

Airbus expects to offer the A3XX to airlines in 1998, and deliver the first aircraft in 2003.—*Bill Sweetman*



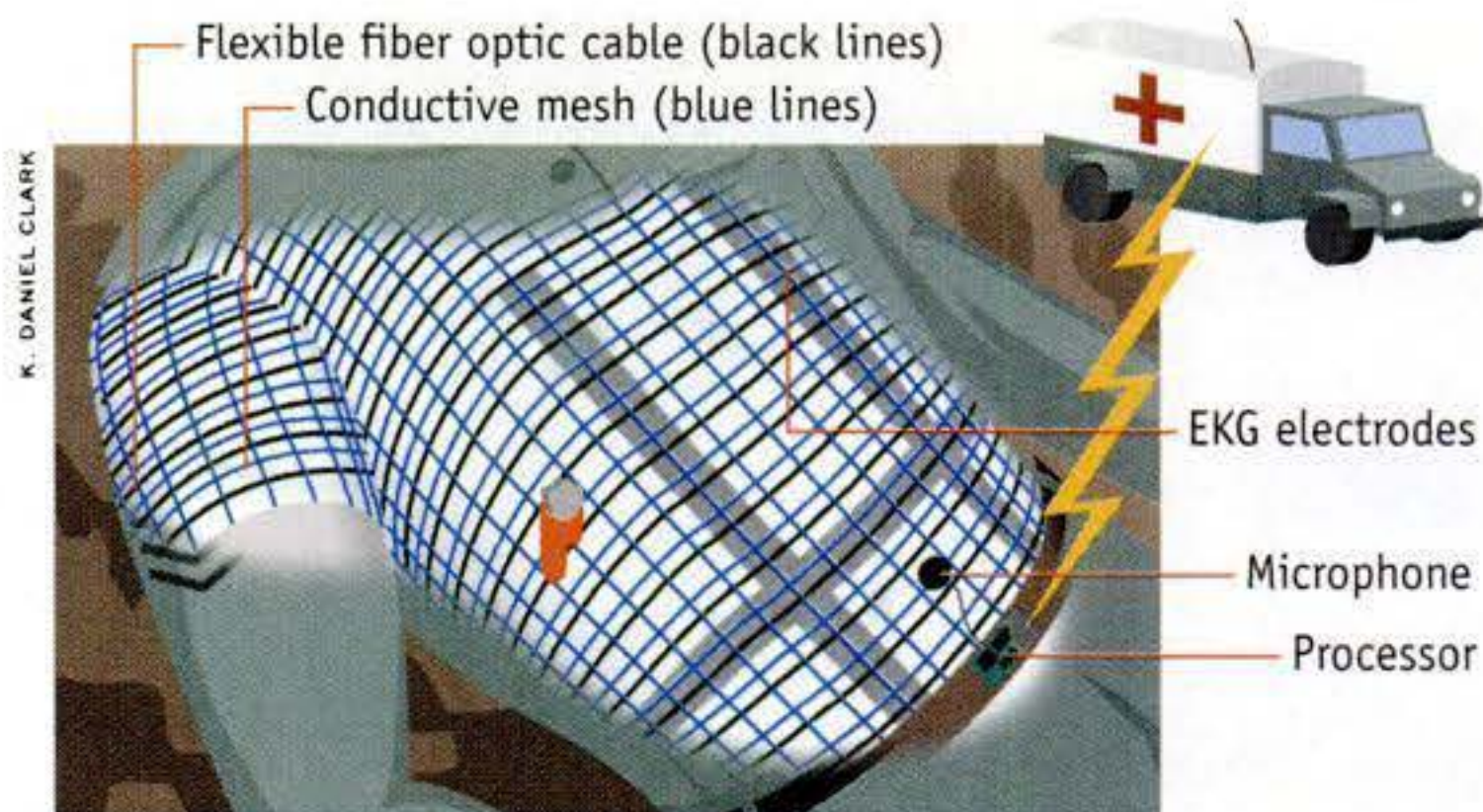
The Airbus A3XX, shown here with the Concorde for size comparison, will be the world's largest airliner.

MILITARY TECH

Wound-Detecting Underwear

WHEN SOLDIERS fall in battle, medics need to know the nature of their wounds to sort out who gets treated first. Is the injury from a bayonet or a bullet? Does the soldier suffer from a flesh wound, torn artery, or internal bleeding? More data means better triage.

Giving a twist to the term "smart dresser," Eric Lind is designing wound-detecting underwear for soldiers of the future. He heads the Sensate Liner program at the Naval Command's Control and Ocean Surveillance Center in San Diego, California. Lind plans to weave electrically conductive polymer threads and strands of optical fiber into the troops' longjohns, and attach microphones to the cloth. When threads



Future soldiers may wear undershirts imprinted with conductive fibers that detect penetration, optical fibers that detect blood, microphones that listen for bullets, and chips that send data to mobile medical units.

are penetrated, the breaks in the circuit instantly trigger the microphones to listen for sounds characteristic of a bullet or a bayonet entering the body, for transmission to the medics.

"You'll bleed over the fiber optics. We'll send a pulse of light through them. The pulse, instead of coming back white, will come back red," says Lind. Reflective spectroscopy will tell medics whether the blood is oxygen-rich, which means "it's coming straight from the heart. You'd move that guy up for triage."

The polymer fibers change resistance when stretched, so they double as strain gauges that measure changes in the soldier's weight. "If we weigh the soldier's arms and legs and they've lost weight, and he's gaining weight in his torso, he's bleeding internally."

So far, Lind has fitted T-shirts covered with microphones and conductive polymers over water-filled garbage bags and successfully recorded the sounds of them being stabbed and shot.—*Dave Cravotta*

AVIATION

Airdrop Paraglider

DROPPING SUPPLIES by parachute has always been tricky. Changes in wind speed and direction can easily throw the load off target.

1 Extraction by parachute

Steerable parachutes guided by Global Positioning System (GPS) receivers have been tested, but strong winds can still cause them to miss their predicted impact points.

Enter the Dragon, developed by United Technologies from equipment invented to recover the space shuttle's rocket boosters. The Dragon's sweptback wing has rigid leading edges and a central bracing strut that fold and telescope, so that the wing fits on top of a cargo container.

2 Drogue (secondary) parachute and wing deployment

The Dragon system uses parachutes and an inflatable wing to make precise deliveries from beyond the range of enemy fire.

3 Release of drogue parachute

To start the airdrop, a small parachute pulls the container through the airplane's rear door. A larger chute stabilizes the load and pulls wires that extend the wing spars. Air flows through an inlet in the center of the leading edge and inflates the fabric wing skins like an air mattress. Once the wing is fully deployed, the second parachute falls away and the vehicle flies at speeds of up to 80 mph under GPS guidance. Like the Wright Brothers' airplane, it is steered by bending its wingtips. The Dragon can land like an airplane or deploy another parachute just above the ground.

United Technologies has made 100 test drops with a prototype Dragon carrying a 500-pound load. The company is working, under an Army contract, on a larger version with a 60-foot wingspan and 10,000-pound carrying capacity. It is scheduled to be tested in 1998.

The Dragon is fast enough to reach its landing spot in the face of 50-mph winds. It can glide up to 20 miles from its release point, allowing a transport aircraft to stay outside the range of shoulder-fired surface-to-air missiles.—*B.S.*

4 Parachute braking for landing



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NON-SMOKER RATES

MONTHLY RATES

ISSUE AGE	\$100,000		\$250,000		\$500,000		\$1,000,000	
	Male	Female	Male	Female	Male	Female	Male	Female
20	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
21	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
22	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
23	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
24	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
25	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
26	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
27	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
28	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
29	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
30	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
31	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
32	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
33	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
34	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
35	12.50	12.50	25.00	25.00	45.84	45.84	87.50	87.50
36	12.59	12.50	25.21	25.00	46.25	45.84	88.34	87.50
37	12.67	12.50	25.42	25.00	46.67	45.84	89.17	87.50
38	12.75	12.50	25.63	25.00	47.09	45.84	90.00	87.50
39	12.84	12.50	25.84	25.00	47.50	45.84	90.84	87.50
40	12.92	12.59	26.05	25.21	47.92	46.25	91.67	88.34
41	13.00	12.67	26.25	25.42	48.34	46.67	92.50	89.17
42	13.09	12.75	26.46	25.63	48.75	47.08	93.33	90.00

MONTHLY RATES

ISSUE AGE	\$100,000		\$250,000		\$500,000		\$1,000,000	
	Male	Female	Male	Female	Male	Female	Male	Female
43	13.17	12.84	26.67	25.84	49.17	47.50	94.17	90.84
44	13.25	12.92	26.88	26.05	49.59	47.92	95.00	91.67
45	13.34	13.00	27.09	26.25	50.00	48.34	95.84	92.50
46	13.75	13.09	28.13	26.46	52.09	48.75	100.00	93.34
47	14.59	13.17	30.21	26.67	56.25	49.17	108.34	94.17
48	15.42	13.25	32.30	26.88	60.42	49.59	116.67	95.00
49	16.25	13.34	34.38	27.09	64.59	50.00	125.00	95.84
50	17.09	13.75	36.46	28.13	68.75	52.09	133.34	100.00
51	17.92	14.59	38.55	30.21	72.92	56.25	141.67	108.34
52	18.75	15.42	40.63	32.30	77.09	60.42	150.00	116.67
53	20.00	16.25	43.75	34.38	83.34	64.59	162.50	125.00
54	21.25	17.09	46.88	36.46	89.59	68.75	175.00	133.34
55	22.92	17.92	51.05	38.55	97.92	72.92	191.67	141.67
56	24.59	18.75	55.21	40.63	106.25	77.09	208.34	150.00
57	26.25	20.00	59.38	43.75	114.59	83.34	225.00	162.50
58	27.92	21.25	63.55	46.88	122.92	89.59	241.67	175.00
59	30.00	22.92	68.75	51.05	133.34	97.92	262.50	191.67
60	40.00	24.59	93.75	55.21	183.34	106.25	362.50	208.34
61	42.09	26.25	98.96	59.38	193.75	114.59	383.34	225.00
62	44.17	27.92	104.17	63.55	204.17	122.92	404.17	241.67
63	46.67	30.00	110.42	68.75	216.67	133.34	429.17	262.50
64	49.17	40.00	116.67	93.75	229.17	183.34	454.17	362.50
65	52.09	42.09	123.96	98.96	243.75	193.75	483.34	383.33

Other amounts available upon request. Premiums are based on applicant's age at issuance of policy. Policies are non-cancellable as long as premiums are paid. Premiums may be paid annually, semi-annually and monthly bank draft only. (A no-cost medical exam may be required depending on age, health or amount of coverage desired). Policies are annual renewable and convertible term. Policy Form No. L-ORD-5101-91, Graded Premium, Level Death Benefit to age 85. Premiums increase annually. Underwritten by United Services Life Insurance Company, Arlington, VA 22203. Established in 1937. Over \$21 Billion of Life Insurance in Force as of 12/31/95. Death Benefit payable for Natural or Accidental Death. **NOT AVAILABLE IN ALL STATES.**

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DATE OF BIRTH _____ ☐ MALE ☐ FEMALE
AMT. OF INS. DESIRED _____ ☐ SMOKER ☐ NON-SMOKER

Comments: _____

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SMOKER RATES

MONTHLY RATES

ISSUE AGE	\$100,000		\$250,000		\$500,000		\$1,000,000	
	Male	Female	Male	Female	Male	Female	Male	Female
20	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
21	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
22	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
23	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
24	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
25	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
26	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
27	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
28	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
29	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
30	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
31	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
32	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
33	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
34	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
35	16.67	16.67	35.42	35.42	66.67	66.67	129.17	129.17
36	17.50	16.67	37.50	35.42	70.84	66.67	137.50	129.17
37	18.75	16.67	40.63	35.42	77.09	66.67	150.00	129.17
38	20.00	16.67	43.75	35.42	83.34	66.67	162.50	129.17
39	21.25	16.67	46.88	35.42	89.59	66.67	175.00	129.17
40	22.50	17.50	50.00	37.50	95.84	70.84	187.50	137.50
41	23.34	18.75	52.09	40.63	100.00	77.09	195.84	150.00
42	24.17	20.00	54.17	43.75	104.17	83.34	204.17	162.50

MONTHLY RATES

ISSUE AGE	\$100,000		\$250,000		\$500,000		\$1,000,000	
	Male	Female	Male	Female	Male	Female	Male	Female
43	25.00	21.25	56.25	46.88	108.34	89.59	212.50	175.00
44	25.84	22.50	58.34	50.00	112.50	95.84	220.84	187.50
45	27.09	23.34	61.46	52.09	118.75	100.00	233.34	195.84
46	28.75	24.17	65.63	54.17	127.09	104.17	250.00	204.17
47	30.00	25.00	68.75	56.25	133.34	108.34	262.50	212.50
48	32.09	25.84	73.96	58.34	143.75	112.50	283.34	220.84
49	34.17	27.09	79.17	61.46	154.17	118.75	304.17	233.34
50	37.09	28.75	86.46	65.63	168.75	127.09	333.34	250.00
51	41.25	30.00	96.88	68.75	189.59	133.34	375.00	262.50
52	45.42	32.09	107.30	73.96	210.42	143.75	416.67	283.34
53	50.42	34.17	119.80	79.17	235.42	154.17	466.67	304.17
54	55.42	37.09	132.30	86.46	260.42	168.75	516.67	333.34
55	60.84	41.25	145.84	96.88	287.50	189.59	570.84	375.00
56	66.25	45.42	159.38	107.30	314.59	210.42	625.00	416.67
57	72.09	50.42	173.96	119.80	343.75	235.42	683.34	466.67
58	78.34	55.42	189.59	132.30	375.00	260.42	745.84	516.67
59	84.17	60.84	204.17	145.84	404.17	287.50	804.17	570.84
60	98.33	66.25	239.59	159.38	475.00	314.59	945.84	625.00
61	103.75	72.09	253.13	173.96	502.09	343.75	1000.00	683.34
62	109.17	78.34	266.67	189.59	529.17	375.00	1054.17	745.84
63	115.84	84.17	283.34	204.17	562.50	404.17	1120.84	804.17
64	124.59	98.34	305.21	239.59	606.25	475.00	1208.34	945.84
65	137.09	103.75	336.46	253.13	668.75	502.09	1333.34	1000.00

Other amounts available upon request. Premiums are based on applicant's age at issuance of policy. Policies are non-cancellable as long as premiums are paid. Premiums may be paid annually, semi-annually and monthly bank draft only. (A no-cost medical exam may be required depending on age, health or amount of coverage desired). Policies are annual renewable and convertible term. Policy Form No. L-ORD-5101-91, Graded Premium, Level Death Benefit to age 85. Premiums increase annually. Underwritten by United Services Life Insurance Company, Arlington, VA 22203. Established in 1937. Over \$21 Billion of Life Insurance in Force as of 12/31/95. Death Benefit payable for Natural or Accidental Death. **NOT AVAILABLE IN ALL STATES.**



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THE HUMAN BODY

Women in Cockpits

FIGHTER COCKPITS and flight suits are generally designed with male pilots in mind. Now that women are also flying fighters, researchers at the Air Force's Human Systems Center in San Antonio, Texas, are experimenting with designs that fit a wider range of body sizes.

The most critical question is whether women respond to high G forces in the same way as men. To find out, volunteers have been riding an upgraded 1,000-horsepower centrifuge that simulates the forces experienced in a modern fighter. So far, differences in tolerance to G forces between women and men are not as pronounced as the variations among individuals. Training and motivation seem to count for more than gender or build.

The tests, nonetheless, are helping researchers redesign the standard G-suit, which puts too much pressure across the stomachs of shorter people. Among the latest garments: the Combat Edge, which pumps oxygen into a pilot's lungs while inflating a "counter-pressure"

vest that keeps the rib cage from expanding, and a new lower-body G-suit that squeezes the legs and buttocks to help maintain blood pressure in the upper body.

Aircraft must also now be redesigned to fit 95 percent of the qualified people in the United States. The Air Force defines the "expanded pilot population" not just by extremes of height and weight, but as a range of body types that includes "shortest reach with high shoulder" and "short limbs with short sitting height." The Beech/Pilatus PC-9 MkII training aircraft, which will be used by the Air Force and Navy, is the first U.S. military plane designed from the ground up to the new standards.

Meanwhile, McDonnell Douglas has designed a "virtual manikin," a computer model of a pilot that covers the expanded population and simulates eye positions and body movements. Using the manikin in conjunction with computer-aided design programs, engineers can see, for example, whether a pilot's hand on the stick will obscure the cockpit displays, or whether the pilot's knees will clear the instrument panel on ejection.—B.S.

CHEMISTRY

Ice That Can Take the Heat

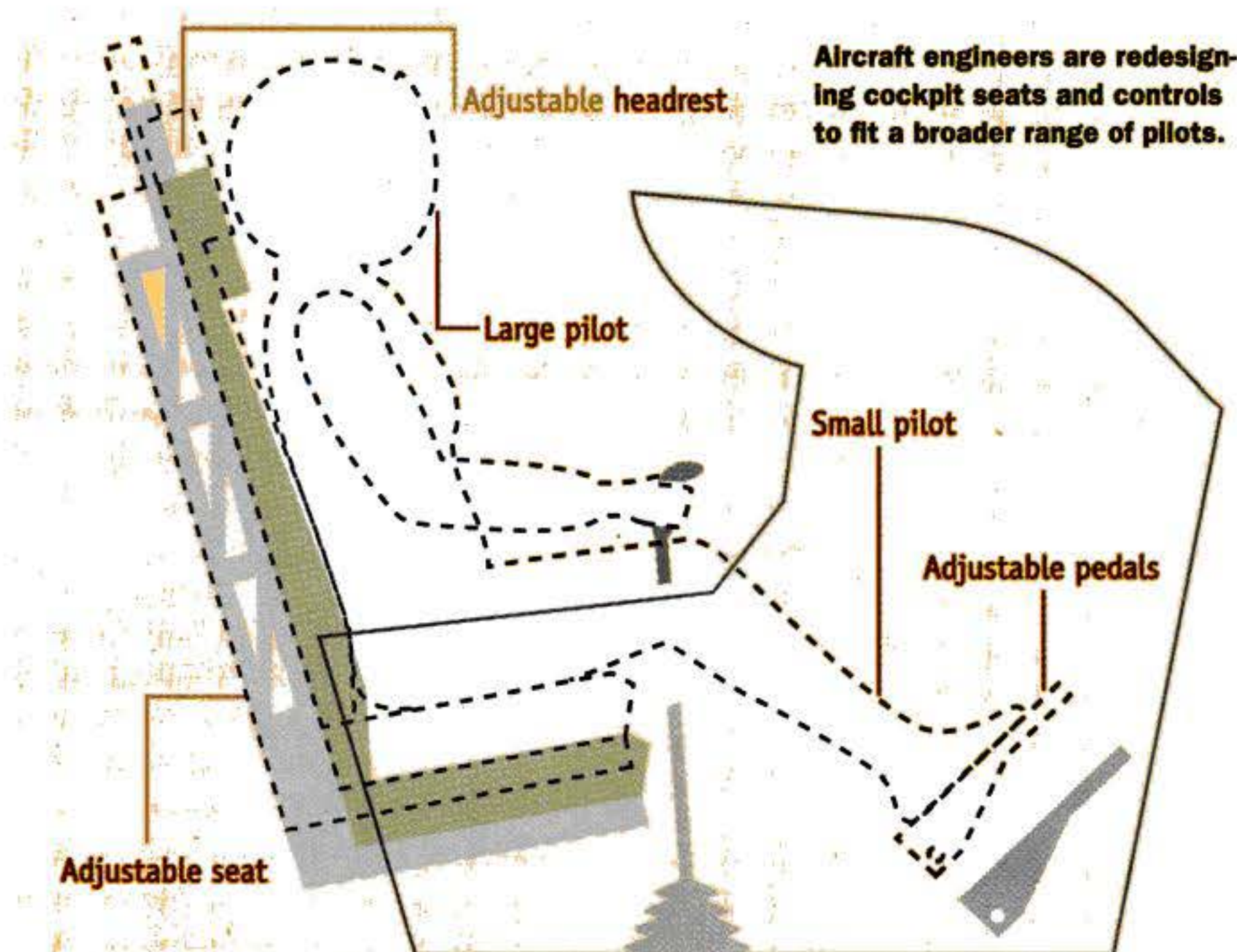
WHEN YOU heat ice to more than 32°F, its melting point, you expect it to turn into water. But that's not what happened when three scientists from the U.S. Geological Survey and Lawrence Livermore National Laboratory tried it. They discovered that when they mixed fine granules of ice with cold, pressurized methane gas, they could heat the ice by 20°F above its melting point before it liquefied.

This "superheating" of the material beyond its melting point without a phase change took the scientists by surprise. "The amount of superheating is absolutely enormous," says Bill Durham of Lawrence Livermore, "and it is very difficult to reconcile with our understanding of thermodynamics and the melting process."

Durham and his colleagues made the discovery while experimenting with a new method for making clathrates, solid compounds of water and methane that have a latticework structure. As the researchers slowly heated a mixture of ice granules and methane, clathrates began to form, but their formation wasn't complete until after about eight hours. During the entire process, the ice was gradually consumed without melting, even at temperatures above 50°F.

The researchers suspect that the molecular structure of clathrates makes the ice resistant to melting. Molecular latticework could have an "armoring effect," they suggest.

The discovery could help scientists learn how methane clathrates form below the ocean floor, and perhaps also on distant, icy moons. These clathrates are a potential source of clean-burning fuel.—D.S.



K. DANIEL CLARK

ELECTRONICS

EDITED BY FRANK VIZARD

VIDEO GAMES

Riding the Wave

WHEN NINTENDO 64 hit store shelves recently, only two games were available, Super Mario 64 and Pilot Wings 64. As good as those games are, it generally takes software developers some time to catch up to a new system's capabilities. With the introduction of Wave Race 64, the system is starting to hit its stride.

What makes the Nintendo 64 system so formidable is a 64-bit, Pentium-class MIPS 4000 processor running at a speed of 93MHz—roughly three times faster than either Sony's PlayStation or the Sega Saturn. In addition, separate processors provide an impressive complement of special effects. These include anti-aliasing, which smoothes out jagged edges by blending background colors; trilinear MIP mapping for crisp 3D images that don't become pixelated when viewed up close; and Z-buffering, which remembers the positions of objects and characters so that when one moves in front of

another, only the unblocked portions of the background object are visible.

In Wave Race 64, another technique, called alpha blending, is added. This creates transparent effects so that players see not only above-the-surface action, but also fish and other riders swimming below the surface. You can even see the reflection of overhead clouds and birds. For added realism, Wave Race 64 uses wave propagation physics—the waves not only look real, they actually affect the way a player's jet-ski interacts with the water. For example, a jet-ski will skim quickly across a glassy lake but slow down considerably in choppy water. And riders trailing another jet-ski will have to contend with the lead jet-ski's wake.

Currently, all Nintendo games are cartridge-based, but Nintendo plans to introduce an accessory that will use miniature discs that hold much more data than cartridges do. Players will be able to write to these discs to store or customize games, and reportedly will enjoy access times that are faster than those of CD-ROMs.—James K. Willcox

AUDIO

Sound sans Speakers

FORGET THOSE boxy speakers. The next sound you hear may come from a disc the size of an Oreo cookie.

Each disc—you'll need two for stereo sound—is covered with small, circular crystals that produce what inventor Elwood G. Norris calls HyperSonic Sound (HSS). Existing speaker systems use electrical signals to vibrate a thin diaphragm and produce sound within an audible range; Norris' crystals pulsate thousands of times faster and generate a pair of ultrasonic waves (one constant and one variable) at frequencies beyond human hearing. The interaction of the two waves produces a third wave that can be heard. By manipulating the variable wave against the constant or reference wave, a variety of tones can be produced using very little power, generally less than 50 watts. The crystals themselves cost little to make.

HSS also creates a startling special effect: Sound can be projected to a certain spot, much the way that light is projected onto a surface with a flashlight. Instead of sound filling a room, it is directed straight at the listener, almost as if it were being created in mid-air. The advantage is that the distortion that's created as the sound bounces off walls and other objects—those echoes that arrive at your ears a little "late"—is eliminated, thus enabling HSS to deliver the fidelity promised by digital compact discs.

Norris' American Technology Corp. is now licensing HSS to several companies. Among the first is Carver Corp., the well-known audio manufacturer, which expects to use HSS in a new product slated for next fall. HSS may be the biggest breakthrough since speakers were invented in 1925.—F.V.



Wave propagation physics realistically simulate a bumpy jet-ski ride in Wave Race 64.

TELEVISION

Ghost Buster

GHOSTS HAVE haunted TV reception from the time video images first took to the air. Now, a technology developed by electronics giant Philips promises to exorcise these uninvited spectres. It's a black box called imageLock (\$200), available directly from Philips under the Magnavox brand.

The name "ghosts" describes the images you see on your TV—wavy, transparent replicas of the main image that seem to follow it like a shadow. The formal name for ghosts is multipath distortion. With broadcast TV, it's caused when the transmitted signal bounces off buildings or terrain on the way to the receiving antenna. These multiple reflec-

tions arrive at your TV at slightly different times, and the ghostly after-images are usually the later arrivals; shifting or smeared color are also symptoms of ghosting. Cable TV can experience ghosting too, but the signal reflections occur within wires of the distribution system.

The Magnavox imageLock is the processing end of a two-part system. To enable the box to reject ghosts, telecasters must transmit a Ghost Cancellation Reference signal (GCR) that makes it possible for imageLock to recognize the primary signal. Most terrestrial broadcasters in major TV markets piggyback the GCR with their signal. Cable television services have not yet adopted the technology widely. If the GCR signal is available, imageLock displays its logo onscreen for four seconds—a solid sphere with two after-images.

The imageLock decoder worked as advertised on broadcasts during an in-home evaluation, using a TV with a rabbit-ears antenna. Mild ghosts vanished and severe ghosting was reduced to tolerable levels. Note that for most installations, you'll need a VCR too, because imageLock requires a tuner signal before passing the decoded image on to the TV. The antenna-equipped VCR tunes a channel and routes the signal to imageLock for processing. The VCR's tuner is almost always necessary, since very few TVs have enough antenna inputs and outputs to work with imageLock alone.

You can also see for yourself how well imageLock works. A demo switch splits the screen to show you a before-and-after picture. For more information call Philips at 800-446-7860.—*Stephen A. Booth*

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TELECOMMUNICATIONS

E-mail by Phone

GET READY for a new wave of smart phones that feature Internet access and e-mail that can be easily viewed on a built-in display.

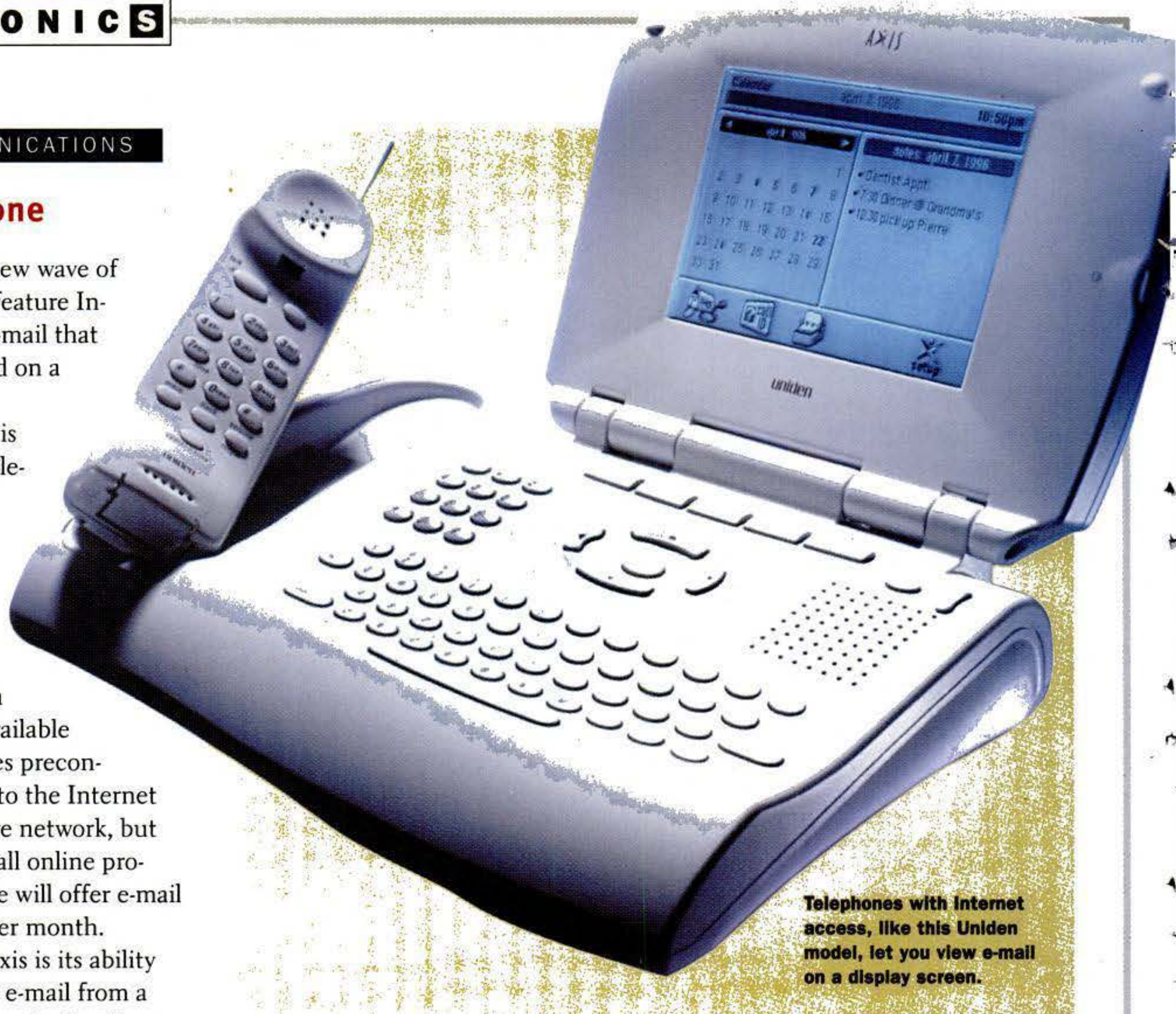
Among the first is Axis, an Internet telephone made by Uniden. Axis combines a 900MHz cordless phone, a keyboard, and a display in one package, for \$399; a corded version is available for \$299. Axis comes preconfigured to connect to the Internet via the CompuServe network, but is compatible with all online providers. CompuServe will offer e-mail services for \$4.95 per month.

The appeal of Axis is its ability to send and receive e-mail from a device that most people already use for communication. And unlike with a PC, you don't have to boot up Axis and open an e-mail application just to check messages. Axis also searches for e-mail at regular intervals, and an indicator light blinks when new messages are received. Axis can store up to 2,000 e-mail

messages; the only drawback is that Axis will ignore attachments and graphics, but you can retrieve those later using a PC. Other features include Caller ID, an electronic address book, a notepad, and a calendar.

Philips already sells a display phone that provides Internet e-mail

through a service from Oracle Corp., and Nortel is expected to upgrade its display phone for e-mail use. Later models may add access to news, stock quotes, and Web sites. Panasonic recently showed a prototype display phone as well, although its availability isn't set.—F.V.



Telephones with Internet access, like this Uniden model, let you view e-mail on a display screen.

SMART CARDS

Health Readings

PEOPLE WHO ARE RUSHED into emergency rooms aren't always in the best condition to answer questions about their medical history. This lack of information can lead to delays or mistakes in treatment. A New York company called EMX LLC is hoping to remedy this problem with a health card that will allow caregivers to have rapid access to the medical data needed to speed emergency care.

The EMX card looks like a credit card and is based on the same technology. It is swiped through an electronic reader that's hooked up to a telephone. A four-digit personal identification number (PIN) provides access to a central database. Within seconds, doctors have a printout of a patient's

medical history, emergency contacts, physicians, and insurers. If a patient is unconscious or otherwise unable to provide his or her PIN, a toll-free number can be called to obtain a patient's records, once the identity of the doctor and hospital have been verified.

More than 100 hospitals in the New York City area have installed the readers, and thousands have purchased the card, says Joseph Bernstein, chief executive of EMX. Critics say the cards raise concerns about privacy, but Bernstein maintains that, ordinarily, only a cardholder can authorize the release of any information. The current EMX card is only the first step. In the future, medical information will be stored on a chip imbedded in the card, eliminating the need to access a database by phone.—Marjorie Shaffer

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Antarctic Meltdown

AT SHACKLETON CAMP, just 300 miles from the South Pole, it is hard to imagine Antarctica as anything but a polar desert. Some 98 percent of this remote continent is covered by a vast, featureless ice sheet that in places runs three miles deep. It is the coldest, windiest place on Earth, with a recorded low of minus 89.2 degrees Celsius. But Antarctica hasn't always been so cold and dry.

During the last Antarctic field season, which ended in early 1996, scientists staying at Shackleton Camp found mosslike plants and sea shells in the nearby Dominion

By Beth Livermore Mountain Range. They say these finds are evidence of a temperate environment that existed only three million years ago, which in geological terms means yesterday.

This scenario has both startled and perplexed the scientific community. Not only does it fly in the face of conventional wisdom, which says that the ice cap has been in place for more than 15 million years, but it also raises questions

SOUTH AMERICA

Polar vision:
Two scientific
camps disagree
on how quickly
the southern ice
cap could melt.

PACIFIC OCEAN



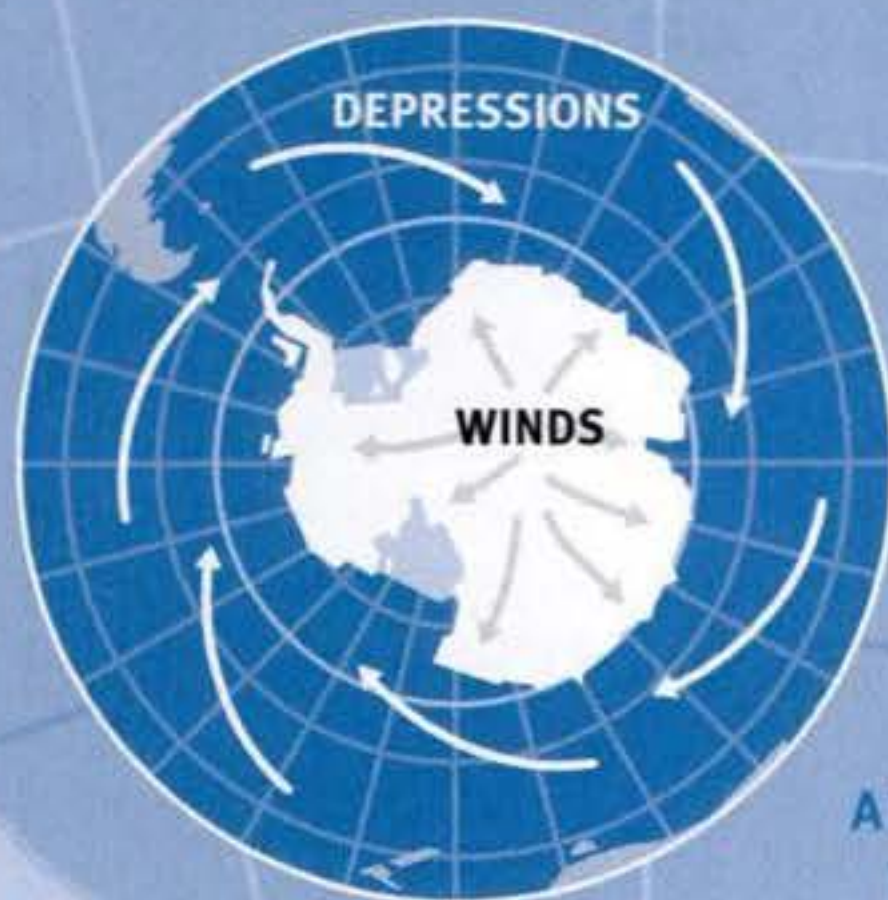
THE GREAT FLOOD

If the Antarctic ice cap were to melt completely, it would raise the level of the oceans by as much as 200 feet, dramatically altering the shape of the United States.



THE ICE CAP

Above: a cross section of the Antarctic ice cap, which contains 70 percent of the world's fresh water and 90 percent of the world's ice. Its average thickness is about a mile, but in some places it is three miles thick.



COLDEST AND WINDIEST PLACE ON EARTH

Antarctica is completely surrounded by oceans over which westerly winds blow freely, forming huge depressions that track around the continent and often spiral in toward it. Winds blowing down from the interior plateau to the coast can reach 180 mph.

SNOW DESERT

The interior receives only slightly more annual precipitation than the Sahara Desert.

ATLANTIC OCEAN

INDIAN OCEAN

WEDDELL SEA

RONNE ICE SHELF

WEST ANTARCTICA

SOUTH POLE

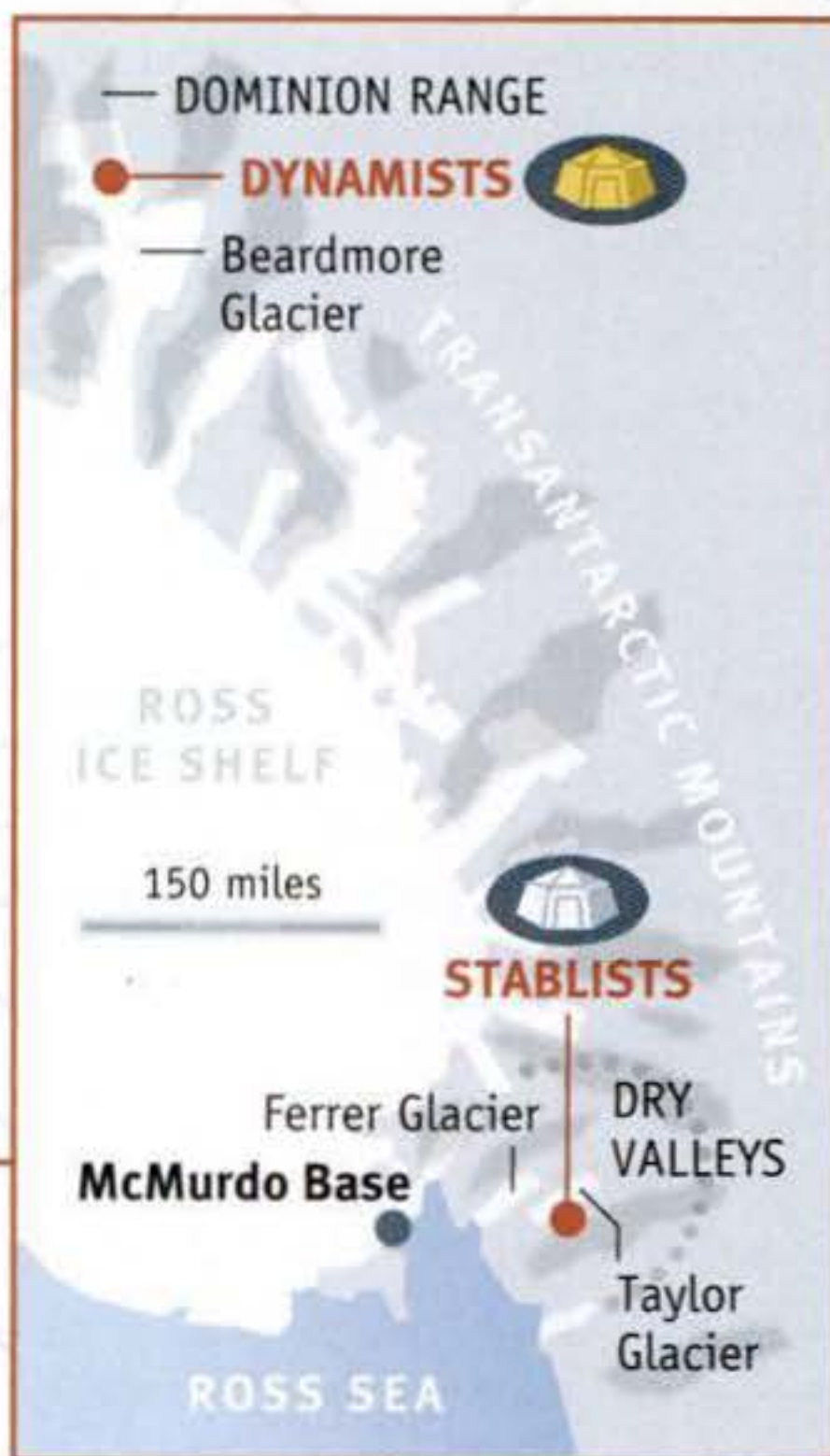
EAST ANTARCTICA

Minimum extent of sea ice

ROSS ICE SHELF

ROSS SEA

Area of detail



SIZE COMPARISON

ANTARCTIC CIRCLE

SOUTHERN OCEAN

INFOGRAPHIC BY JOHN GRIMWADE

about the validity of current climate models that are based on a frozen Antarctica.

The Transantarctic Mountains divide the Antarctic ice cap into two regions. **To the west, south of Argentina, an ice sheet sits anchored to bedrock below sea level.**

Researchers have long worried that this western sheet might one day slip off into the ocean, and there is plenty of evidence that it could. But what really worries people is the possibility that the much larger eastern ice sheet, south of New Zealand, might also melt. This ice sheet rests on land and was, until recently, presumed to be stable. But now there is mounting evidence that the eastern sheet may have shrunk significantly three million years ago during the Pliocene, the world's most recent warm period.

If there was a major meltdown during the Pliocene, it could happen again. Antarctica, which is almost twice the size of Australia, contains 90 percent of the world's ice and 70 percent of its fresh water. So even a partial melting could flood coastal cities and swamp fertile farmland. If

the entire ice cap were to melt, sea levels could rise as much as 200 feet. This would make Memphis a deep sea port, turn Miami into a scuba-diving destination, and create an island out of the Empire State Building.

So, are we headed for *Waterworld*? Should we build our homes on stilts? Scientists are divided on this issue. One camp, the "dynamists," believes that the Antarctic ice sheet is dynamic: It has undergone rapid changes in the recent past, and could do so again. The other camp, the "stablists," believes that the Antarctic ice sheet is stable and unlikely to melt away in the foreseeable future. To see what evidence is being gathered to settle the debate, I flew south last year to visit members of the two factions during their field seasons.

Getting to Antarctica requires an eight-hour flight to McMurdo Research Station from Christchurch, New Zealand, in the equivalent of a B-52 on skis. You wear full polar gear, including a pair of massive rubber moon boots, two sets of long underwear, polyester overalls, and a fur-trimmed parka. Passengers strap in,

"I tried to ir dynamists like the gre

shoulder-to-shoulder, on benches made from cloth webbing.

After landing at McMurdo, I took a second flight to Shackleton Camp, where the **dynamists'** team had been working for the past two months. Stiff from the long, cold ride, I stood up, stretched, and looked through the window for any sign of life in this foreboding, desolate land. I saw six Quonset huts, a handful of tents, and two outhouses perched on a slab of ice in the middle of a mountain valley. Once outside, my parka rippling against the freezing wind, I tried to imagine a land that the dynamists say once looked like the green fjords of Chile. I quickly gave up, and walked as fast as I could toward food and shelter. On the way to the hut, I ran into David Harwood of the University of Nebraska, who was returning to McMurdo to pack off his samples. There on the airstrip, he laid out the details of his story. By the end of the tale, the idea of water in valleys like this one seemed almost plausible.

It all began in 1983 when Peter Webb, a geologist at Ohio State University, and Harwood, then a graduate student, performed a laboratory analysis of glacial sediment from the Transantarctic Mountains. What they discovered was astonishing: The sediment, known as the Sirius Group, contained diatoms, or marine microfossils, that were only three million years old. This suggested that the climate during the Pliocene may have been warm enough to melt the ice cap and allow the ocean that surrounds Antarctica to flood its subglacial basins. Later that year, Harwood left for the frozen continent, where he dug up additional sediment samples

What About the West?

WHILE THE FATE of Antarctica's eastern ice sheet is uncertain, scientists have plenty of reasons to believe that the smaller western sheet could eventually slip into the ocean. It is the world's only remaining marine ice sheet. The others, which existed in the Northern Hemisphere, disintegrated and melted away during the Pliocene period.

There are signs that the west Antarctic ice sheet is already breaking up. A huge iceberg broke free of the Larsen ice shelf in 1995. Shortly thereafter, a 40-mile-long crack opened in the adjoining shelf area. Now, ice streams that flow through the sheet are behaving erratically.

Last year, Stanley Jacobs of Columbia University's Lamont Doherty

Earth Observatory made the first oceanographic measurements across a deep channel beneath the leading edge of Pine Island Glacier. His findings show that the west Antarctic ice sheet is losing mass to the oceans. But whether this instability is symptomatic of an impending collapse remains unknown.

To further study the current state of the west Antarctic ice sheet, and to predict its future, the National Science Foundation is sponsoring a variety of Antarctica-based research projects. For example, Cal Tech scientists at Upstream Bravo Camp are sinking ice strings and digging ice cores to study the movement of fast-flowing ice streams. They're also burying seismic monitors in snow fields to listen for "ice quakes" set off by colliding ice sheets.— B.L.

Imagine a land the way once looked in fjords of Chile."

from the Reedy Glacier area. They too contained diatoms of three-million-year-old vintage.

At first the findings were dismissed. The few scientists who gave them any thought said that the diatoms must have somehow blown into the sediment from the sea floor. It was a fluke, they said.

Back in 1983, it was generally agreed that after Antarctica splintered from the southern supercontinent Gondwana over 100 million years ago, it slid into a deep freeze, accumulating an ice cap that has remained about the same size for the past 15 million years. There was no reason to doubt this picture. It was supported by geological studies of Antarctica, as well as deep-sea oxygen isotope measurements that reflect ice volume and temperature changes.

But in 1985, Webb and Harwood visited Beardmore Glacier, where they found bits of wood later identified as southern beech. This made them think that perhaps small trees once grew there. They confirmed this hypothesis in 1990 by unearthing beech tree leaves and roots. The survival of these plants, they say, indicates a prolonged warm period.

Three years later, beetle remains turned up in the rubble. With this find, Harwood and Webb's notion of a dynamic ice sheet and climatic shifts finally grabbed the interest of a cadre of experts. "The survival of a beetle during the Pliocene in Antarctica implies that temperatures were significantly warmer than present," says micropaleontologist Allan Ashworth of North Dakota State University in Fargo.

In the field season that ended in

1996, Harwood and Webb took further steps to investigate their theory. First, they revisited the Dominion Range to collect more fossils. Then, they scoured a new site called Bennett Platform, and studied its geology. Finally, they collected samples from 15 other Sirius sediment sites throughout the Transantarctic Mountains to sift for diatoms. "If they blew in, then there should be a uniform distribution of them," Harwood says. They should also vary in age.

It will take several years to analyze the diatom populations. In the meantime, Harwood and his team are puzzling over a mosslike plant colony found at Bennett Platform. Harwood says it probably grew in wetlands that were eventually covered by silt from a nearby river or stream during a glacial advance. The geology of the area, which is part of the Sirius Group, sug-

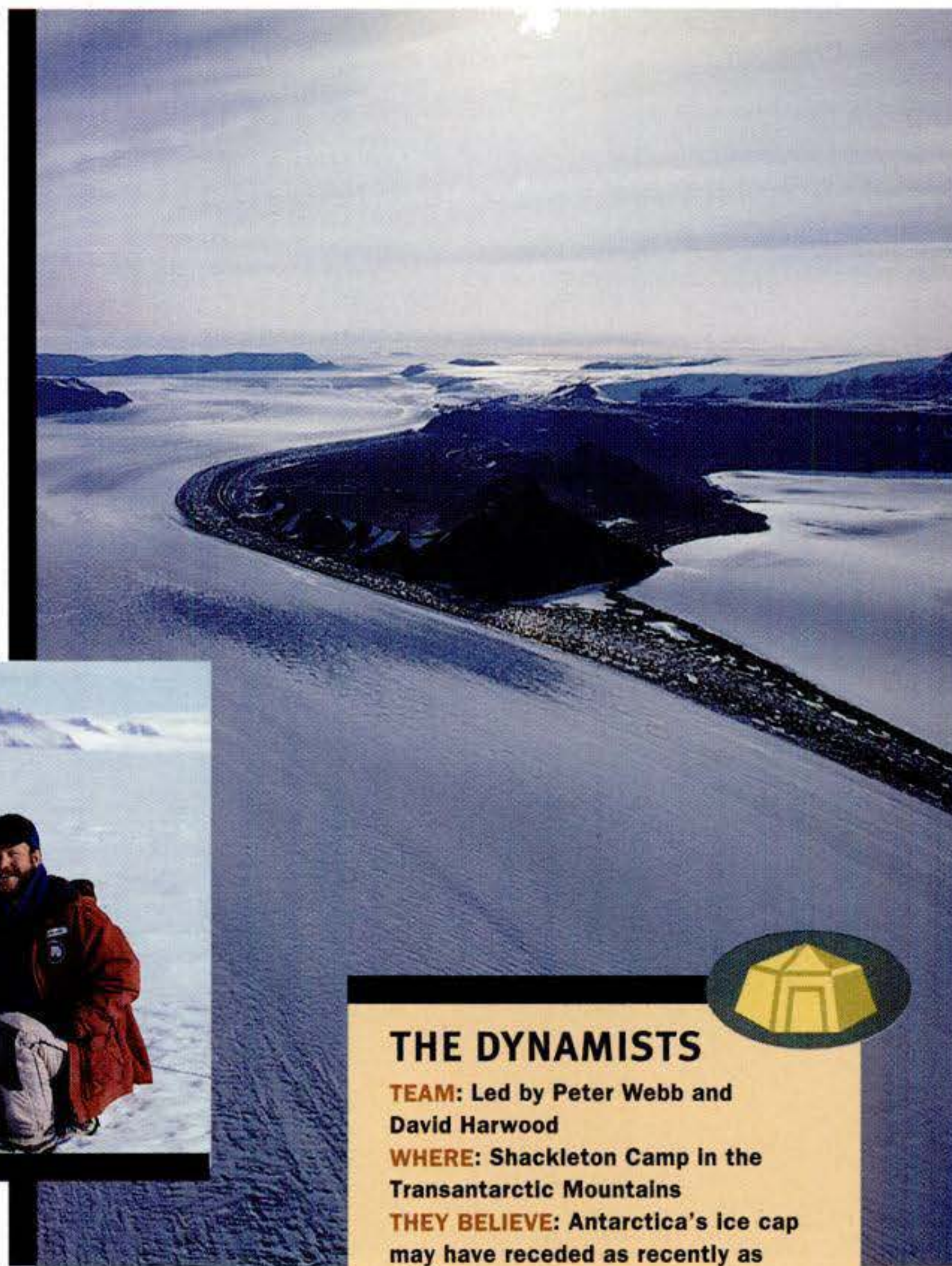
gests that a lot of water was present when the rock face formed.

Ashworth also made a fascinating discovery: He found seeds and sea shells in the box of rocks he brought back from the field last year. "They're interesting in their own right," he says, because neither fossil group had previously been found on Antarctica. But their true value may be in their ability to date the sediment in which they were found.

Meanwhile, a variety of other research has begun to yield supportive evidence. One study suggests that



Harwood (Inset) camps on Shackleton Glacier, where summer temperatures usually stay below freezing. Above is Bennett Platform, where Harwood's team found a mosslike cushion plant.



THE DYNAMISTS

TEAM: Led by Peter Webb and David Harwood

WHERE: Shackleton Camp in the Transantarctic Mountains

THEY BELIEVE: Antarctica's ice cap may have receded as recently as three million years ago.

THE PROOF: They found sediment containing marine microfossils that are only three million years old, suggesting that the climate then may have been warm enough to melt the ice cap and allow ocean water to flood Antarctica's subglacial basins.

WHAT IT MEANS: If the eastern ice sheet shrank significantly during the Pliocene, we can expect another big thaw the next time Antarctica's temperature rises by a similar amount.



THE STABLISTS

TEAM: Led by George Denton and David Marchant

WHERE: Camped at Bull Pass in the Dry Valleys

THEY BELIEVE: Antarctica's ice cap has been stable for the last 10 million to 15 million years.

THE PROOF: They collected rock and ash samples from the same sedimentary layer studied by the dynamists, and these samples show no signs of wetting or erosion, which suggests they were not disturbed by a receding ice sheet as recently as three million years ago.

WHAT IT MEANS: If the continent's eastern ice sheet remained frozen in place during the Pliocene, Antarctica would have to heat up dramatically before any significant melting recurs.



Glaciers turn to sand at the Dry Valleys (left). Marchant (above in red) shows Denton a hollow where he found volcanic ash.

Canyon, plus ephemeral streams, levees, and sand beaches.

Denton has worked here for more than 20 years, and knows more about this landscape than anyone else in the world. Now, to learn more about the climate during the Pliocene, Denton and Marchant are combining their study of the landscape (geomorphology) with that of ash that blows into the area from offshore volcanoes.

I land in Bull Pass, a desert pavement 20 miles from Mt. Fleming. It is so flat and so barren that it has been likened to Mars before the big freeze. Indeed, there is no visible sign of life

except for a tiny camp consisting of two tents and a portable stove. As we hike over what look like the rounded backs of dinosaurs, Denton tells me that he believes Antarctica's massive ice sheet has remained fairly sta-

ble for 10 million to 15 million years.

Marchant then strolls over to a sandy mound where he has been digging for ash with a trowel. He says that he reads the history of climate by examining how rocks weather, and where they are found. Then, for a chronological framework, he looks for nearby volcanic ash. Ash, like rocks, can reveal environmental clues through its content and current condition. And because it is the last thing to land on the surface of a formation, it can pinpoint a minimum age for the rocks.

Marchant and Denton have collected rock samples from Mt. Fleming and Table Mountain, nearby peaks with the same Sirius Group glacial sediments as the area around Shackleton Camp. The two scientists say these rocks have been preserved in dry and cold conditions, and show no sign of erosion. This suggests that the Dry Valleys have remained a cold desert for much longer than three million years.

“This place was like no other that I had seen in Antarctica.”

warm-blooded sea creatures, including dolphins, may have migrated closer to Antarctica during the Pliocene, which would have meant warmer water.

Other studies have found evidence that, about three million years ago, sea levels were between 25 and 30 meters higher than they are now, perhaps due to ice cap melt.

“The evidence is quite compelling,” says paleontologist Brian Huber of the Smithsonian's Museum of Natural History. But not to the stablists. A period of climatic warming at a time when other evidence suggests Antarctica was completely covered by ice

remains unacceptable to many scientists. To hear the **stablists'** side of the story, I flew to Antarctica's Dry Valleys to meet with George Denton of the University of Maine, and David Marchant of Boston University.

As I flew by helicopter over McMurdo Sound toward the Dry Valleys, I soon realized that this place was like no other I had seen in Antarctica. There is no ice or snow in the Dry Valleys. Mummified seals lie in heaps. Wind-sculpted rocks decorate the hillsides. This area, which is about 1,260 square miles, has rifts and valleys no less impressive than the Grand

The team has also mapped 75 ash deposits, and obtained dates for 50 of them. The samples show that the ash formed in a cold, dry environment, and remained undisturbed. It was found on rocks that are unmarked by any massive ice-sheet movement.

In addition, geologist David Sugden of the University of Edinburgh in Scotland has found an eight-million-year-old ice slice in the Dry Valleys that he says could not have survived a warming period. And cores extracted from the ocean floor around Antarctica show no curtailment of sediment from melting icebergs, as would be expected if the continent was partly ice free during the Pliocene.

Taken together, these results speak volumes in favor of a dry, cold, steady state. They indicate that the Pliocene temperatures were only three to eight degrees Celsius above today's temperatures, and that the ice sheet covering the Transantarctic Mountains overrode the area more than 10 million years ago.

"We do not deny that Harwood is finding the fossils," says Marchant. In fact, he says, "we'd expect it." Before Antarctica split from Gondwana, it supported many of the same plants and insects that are now found in South America and New Zealand. So these fossils may represent the last vestige of these life forms. "What we disagree with is the timing of it all," Marchant says.

While Harwood and Webb contend that their miniature forest withered three million years ago, Denton and Marchant argue for at least 23 million years ago, when Antarctica was clenched firmly by the icy grip that still holds it today. "Their entire argument relies on the diatoms, which we think may have blown in," Marchant says. Meanwhile, Harwood questions the validity of the Dry Valleys results, saying "that area is anomalous now, maybe it was then too."

For now, the argument remains unsettled. Though Harwood says that both camps may eventually prove to be correct—that there was a long period of cold punctuated by relatively

How Antarctic Ice Affects World Climate

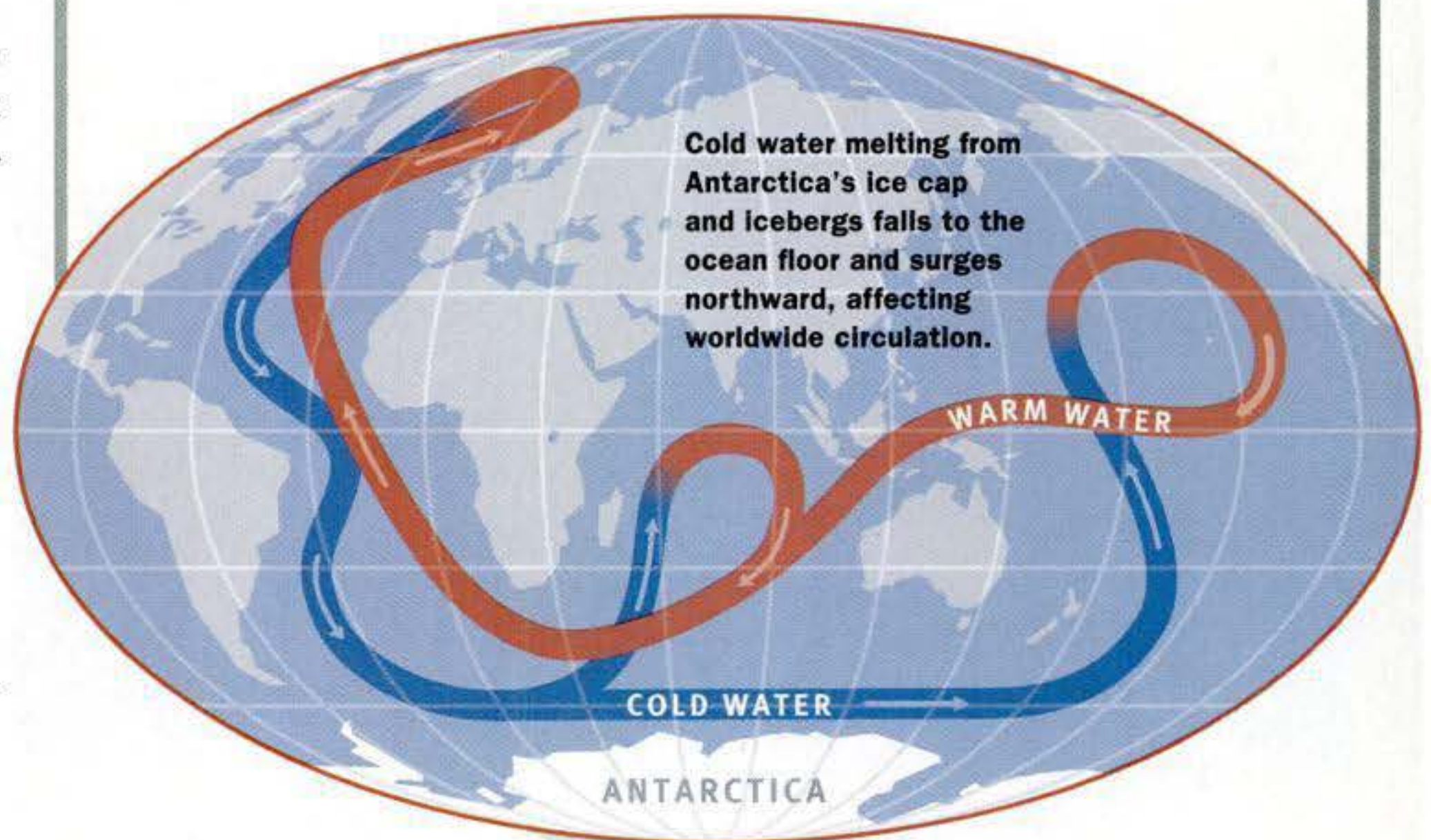
THINK OF THE Antarctic ice sheet as Earth's refrigeration unit: It exerts a major two-way control over today's global environment.

First, the ice sheet (along with a raft of ice that surrounds it in the southern ocean) reflects back into space about 80 to 85 percent of the sun that hits it. So icy Antarctica, which records the coldest temperatures on Earth, helps to reduce the world's overall heat budget.

Second, the near-freezing melt-water that runs off the ice cap, along with the water from melting icebergs, falls to the ocean floor and

surges northward. This surge affects deep-sea circulation, which in turn influences climate. So, a major melt-down would not only raise sea level worldwide, but could also modify weather patterns.

For a better fix on the details, the National Oceanic and Atmospheric Administration is monitoring weather, ozone depletion, and long-term climate trends at the South Pole. In addition, scientists are refining their models of the oceans and the atmosphere by studying bottom water in Antarctica's Weddell Sea, and satellite images of sea ice.—B.L.



short bursts of heat—Marchant disagrees, saying "these are mutually exclusive positions and there is no evidence for an intermediate theory."

About the only thing both camps agree on is that the key to solving this mystery is to establish, once and for all, the age of the Sirius sediment fossils. Although this will be difficult, because there is no definitive technology on which to rely, an attempt will be made this year. An independent group of researchers will drill a core from the Sirius Group rocks to determine whether diatoms exist below the surface (and therefore are unlikely to have been windblown), or only near cracks or at the top.

Both groups recognize the urgency

of coming to a firm conclusion.

The Antarctic ice sheet affects not only global sea level, but also world climate. So agreement on a clear picture of the past could help to cast a more accurate vision of Earth's future. If the stablists are correct, and the eastern ice sheet remained frozen during the Pliocene, then there is little reason to worry about the fate of our coastal cities. A major temperature increase would be required to have any effect. But if the dynamists are right, and the ice sheet did melt down, then a moderate rise in the mercury could one day bring on the floods. For now, however, the answer lies hidden in Antarctica's frozen landscape. ♦

Stealth on Wheels

Motorsports
meet military
in a stealthy
off-road truck.



RUSHING ACROSS APPALLING Mojave Desert terrain at a speed that no trusty Jeep—or even a Humvee—could ever achieve, I'm worried about losing four expensive dental crowns installed just a few days ago.

By Stuart F. Brown

The surface ahead looks like familiar dirt-road washboard, except that the undulations are a few feet tall instead of a few inches. Cinch the harness straps a little tighter, brace for impact.

Whump-squish, whump-squish, whump-squish, growl. We're past the *whoop-de-doo*s, and sprinting up a 50 percent grade littered with sharp rocks before I notice that the correct number of teeth are still in my head. This is remarkable.



PHOTOGRAPHED BY JOHN B. CARNETT



In the driver's seat, grinning with pride at what this buggy can do, is Rod Millen, a winning off-road racer whose company built the chassis that makes gigantic bumps feel like they are, well, only big ones. And underneath the desert-beige skin is an exotic diesel-electric hybrid powertrain developed by AeroVironment Inc., the company that has built pioneering solar-electric vehicles and achieved milestones in human-powered flight.

Like all things military, this truck has an acronym: JTEV, short for Joint Tactical Electric Vehicle. The JTEV is a "technology demonstrator," designed to wed chassis and suspension wisdom from the rough-and-tumble world of off-road racing with the latest thinking in high-efficiency electric drivetrains. Funded by the Marine Corps and managed by the Naval Surface Warfare Center, the program aims to explore advantages that hybrid propulsion might confer on soldiers conducting high-speed special operations or reconnaissance missions in hostile territory.

One major benefit is stealth: Running in electric-only mode using energy stored in its battery pack, the JTEV can travel very quietly for about 10 miles. And since little heat is generated by a battery-driven powertrain, visibility to an enemy's infrared night scopes is greatly reduced.

Quiet it is in battery-electric mode, as I discover during a spell behind the wheel. Some moderate gear whine accounts for most of the sound the vehicle makes. After about a mile of electric cruising, I push a yellow button on the instrument panel to ignite the diesel. Now a familiar grumbling clatter emanates from under the hood, its pitch rising and falling as the truck negotiates a winding power-line road through a cluster of dusty hills.

Sitting on the passenger side is engineer Catherine Anderson, AeroVironment's program manager, who appears to appreciate my decision to proceed at about one-third of the Rod Millen pace. He's gifted; I'm not. And I don't want to be the one who totals a one-of-a-kind machine that represents thousands of hours of engineering and skilled fabrication work.

The meandering diesel note emanating from the electric vehicle's insides is reminiscent of the strangely disconnected sounds drivers notice in Honda Civics and Subaru Justys equipped with continuously variable transmissions. In these vehicles, engine speed is not mechani-



How does the narrow JTEV (far left) handle rough country at high speeds? Its wheels have a suspension travel of 18 inches, twice that of the Humvee. Long, beefy A-arms link the differentials to the wheels and transmit the kinetic insults coming from the ground to huge shock absorbers packed with sophisticated hydraulic damping valves (above left), which convert the energy to heat. Despite its spartan interior (below left), the JTEV provides a surprisingly comfortable ride.

cally locked to the speed of the wheels. It follows its own muse as the transmission seeks new ratios to match the demand created by the driver's foot on the gas pedal.

But the JTEV's rising and falling diesel sound cannot be explained by a novel transmission—because there isn't any. How then, does power get from its 2.1-liter Peugeot turbodiesel to the axles? Heavy-duty electrical cables. This is an all-wheel-drive truck with no mechanical connection between the two ends of its powertrain.

Where the four-cylinder diesel's French maker had originally bolted a flywheel and clutch, AeroVironment engineers installed a huge 60-kilowatt alternator that puts out 60 times the electric power of the alternator in a typical passenger car. The brushless DC alternator's output flows through a suite of electronic inverters, converters, and microprocessors. These condition the power for driving a pair of AC induction motors at the front and rear wheels and charging the 800-pound lead-acid battery pack. The alternator also doubles as a starter motor for the diesel engine.

The software in the electronic controller that manages the JTEV's power budget is designed to maximize driving range and the life of the battery pack, which is about the same size as the one used in General Motors' EV1 production electric car. AeroVironment, which developed the original prototype that evolved into the EV1, selected a pair of EV1 electric motors to drive the JTEV's front and rear wheels.

The truck sprints briskly away from a standstill when I step on the accelerator, as the control circuitry routes power from the battery pack to the electric drive motors. The diesel engine adjusts its running speed to keep the battery pack charged—hence the lack of harmony between road speed and engine rpm.

The big alternator produces copious amounts of heat, so a high-volume forced-air cooling system is used to keep it at a safe operating temperature. Warm air from the alternator is routed to a mixer box behind the passenger seat, where it mingles with the diesel engine's exhaust. As a result, the diluted exhaust exiting from a port on the truck's right side has about half the infrared visibility of pure diesel exhaust. Stealth aircraft use a similar method to reduce their vulnerability to heat-seeking missiles.

The military's penchant for carrying its equipment around in helicopters dictated the JTEV's 5,000-pound maximum weight and its narrow 65-inch width, which are tailored to the cargo bays of the CH-46 helicopter and the future V-22 Osprey tilt-rotor aircraft. A Humvee, by comparison, has a gross weight of 7,700 pounds, and is famously wide at 86 inches.

Making the narrow JTEV stable enough to handle rugged country at high speeds was a challenge to Millen's suspension designers. They decided the best approach was to give all four wheels a long suspension travel of 18 inches. Making it work required the development of special minimum-width gearbox and differential units. They reduce the speed of the electric motors and transmit power to halfshafts that are as long as possible, given the space available between the truck's wheels. "A suspension with 18 inches of travel and shorter halfshafts would force its universal joints to run at too steep an angle, and would quickly destroy them," says chassis engineer Jack Auld of Rod Millen Motorsports.

Huge shock absorbers soak up the bumps, converting kinetic energy into heat that is dissipated when the hydraulic oil passes through aluminum reservoirs located in the airstream. A ride-height adjustment system lets the driver increase the vehicle's ground clearance from 10 to 15 inches when motoring over rocks and other obstacles.

Aside from stability, the point of all this high technol-

ogy is old-fashioned comfort for the crew, and less wear and tear on their electronic equipment. While some soldiers may be proud of how much pain they can endure, off-road racers take a different view. "When you see those trucks on TV blasting down the Baja peninsula, it looks like murder," says Millen, "but actually, the suspension systems are giving those guys a pretty good ride. If I'm being bashed to pieces, I can't win a 10-hour race."

The team of AeroVironment and Millen Motorsports engineers is testing the JTEV at an off-highway vehicle area in the windy desert near Barstow, California. Wired with accelerometers and other sensors that measure suspension-deflection rates, wheel speeds, and the amount of vertical force experienced at the driver's seat, the truck bashes along stretches of rough terrain with a plywood box of sandbags in the back, bringing it up to maximum weight.

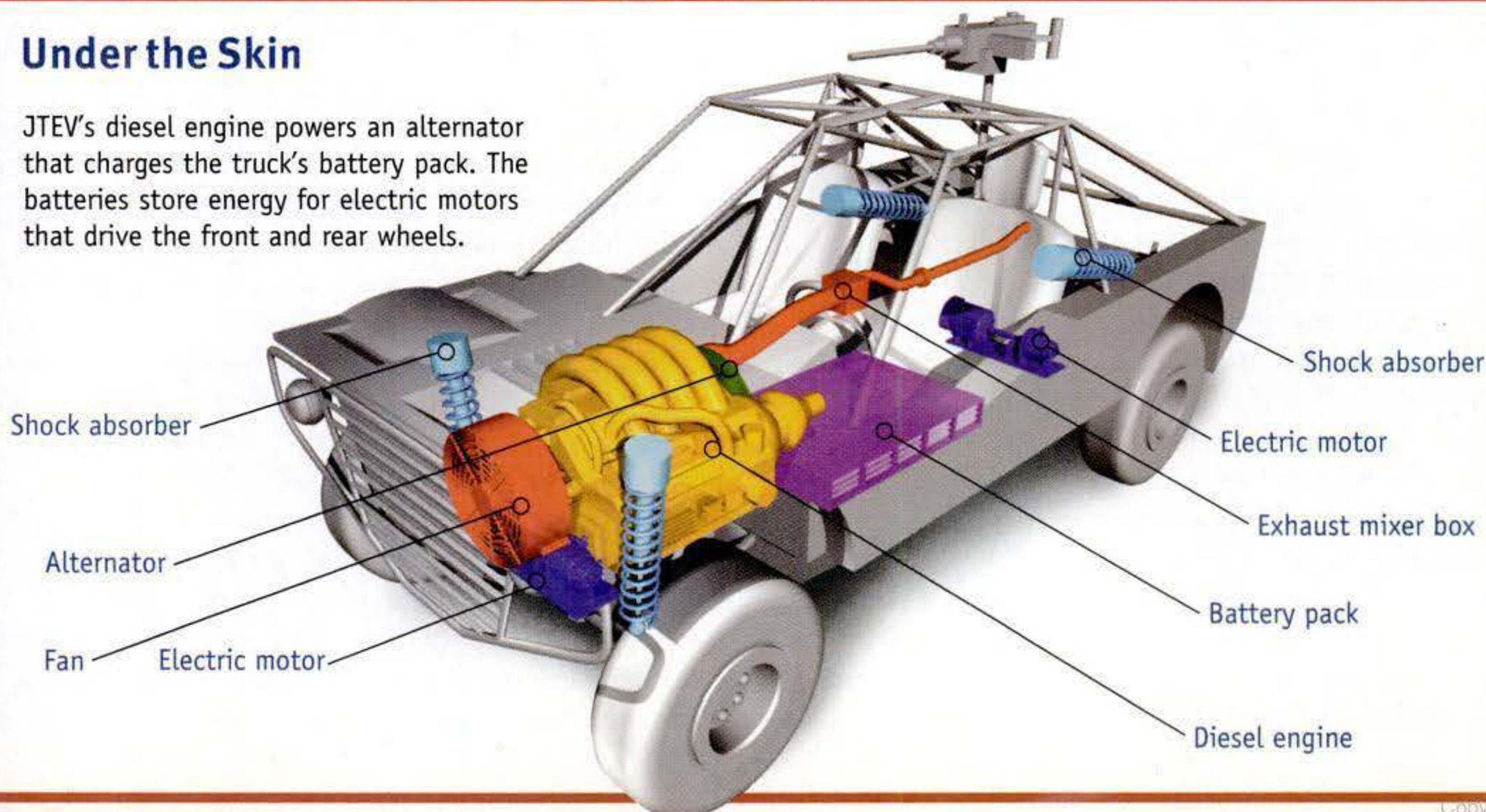
The engineers have carefully marked off an undulating course, a bumpy course, and a truly inhospitable course. With Millen at the wheel and a laptop-toting engineer at his side, the truck flies across the terrain at varying speeds, generating lots of behavioral data. Back at AeroVironment's lab in Monrovia, California, the information is entered into a database that will be used to improve designs for next-generation war trucks built around hybrid powertrains.

Putting power to the ground through electric motors is an idea that has appealed to military vehicle designers for a long time. In 1943, General Electric's Erie Works built a prototype electric-drive tank called the T23 for the U.S. Army, which was concerned with countering the improving firepower and mobility of the German Panzer tanks then operating in North Africa.

The T23 used a 500-horsepower Ford V8 engine to power a generator, which in turn drove electric motors located at each track. The Army's Detroit Tank Arsenal soon put the T23 into production, and by late 1944, 250

Under the Skin

JTEV's diesel engine powers an alternator that charges the truck's battery pack. The batteries store energy for electric motors that drive the front and rear wheels.



Electric Trailer

THE PREDECESSOR TO JTEV is a somewhat boxier-looking experimental vehicle, funded by the Marine Corps, called the Helo Transportable Multi-Mission Platform. Work on the HTMMP (pronounced "hightemp") began in 1991, aimed at exploring the idea of a high-mobility vehicle narrow and light enough to be carried by helicopters.

The HTMMP has a six-cylinder turbodiesel engine built by Steyr of Austria; it powers all four wheels through con-



ventional driveshafts and an automatic transmission. Yet a peek under the hood reveals a huge alternator. What's it for? The HTMMP is designed to tow a unique trailer that has electrically driven wheels to keep the truck from getting bogged down when it's hauling a heavy payload. A hydraulic stabilizing system fights the jackknifing or rollover that could occur on rough terrain. Together, the HTMMP and its fancy trailer constitute an articulated, six-wheel-drive diesel-electric vehicle.—S.F.B.

of them had been built. The logistic challenge of fielding skilled maintenance technicians and spare parts proved to be the T23's downfall, however; none saw combat service. The sole surviving example remains in the collection of the Army's Tank Automotive Command in Michigan.

Today, the military has a gaggle of electric-vehicle research and development programs underway. The Defense Advanced Research Projects Agency is funding the development of two electrified versions of the Humvee, one designed for maximum performance, and the other for conversion to hybrid diesel-electric drive at minimum cost. DARPA has also funded the construction of a battery-electric M-113 tracked armored personnel carrier, which is now being converted to hybrid power with the addition of a diesel engine and alternator.

Meanwhile, the Marine Corps is testing a trailer with electrically driven wheels. The Marines are also retrofitting an older amphibious assault vehicle with a diesel-alternator powertrain that drives electric motors directly without using batteries. And contractors will be asked this spring to submit proposals for a new reconnaissance, surveillance, and targeting vehicle, or RST-V. The vehicle's specifications will call for a hybrid diesel-electric powertrain.

One of the most important things such a vehicle can offer is an abundance of onboard electric power, a commodity the military consumes with ever-increasing thirst. According to Michael Gallagher, head of the Marine Corps Vehicles Department in West Bethesda, Maryland, power is needed for reconnaissance sensors, radios, and perhaps for future weapons using directed-energy beams. "We also want to power off-board equipment such as radar

or electronic-warfare equipment," he says. "The truck could even be used to jump-start an aircraft or a tank."

But the biggest payoff of hybrid power and lighter weight is fuel economy. "Hauling fuel is a big logistic burden for the Marines," says Gallagher. "We think we can double the cross-country fuel efficiency of the Humvee, which is about nine mpg. A hybrid only needs a relatively small engine, which is sized for average loads, and it borrows from the batteries to sprint or climb a hill. This is the way to be fuel efficient."

Since the JTEV program began three years ago, about \$2 million of Marine Corps funds has been spent on design, fabrication, and testing of the vehicle. Another \$2 million is earmarked for further testing and development, half coming from DARPA and half from the Marines. DARPA's share will pay for the development of advanced electrical components including a semi-active suspension and a nickel-cadmium battery pack.

Switching to nickel-cadmium batteries will make it possible to add a regenerative braking feature that will improve fuel efficiency. "We've written the computer codes for controlling regenerative braking, but the lead-acid batteries we have now won't accept current at a high enough rate," says Anderson. "Regenerative braking would slam those batteries really hard, and they wouldn't last long."

The hardest part of developing this ambitious experimental war truck has been "working all the gremlins out," Anderson says. "They are everywhere when you build so many new systems all at once. We make things and break them and make them over again. This has taken a lot of persistence, but finally the truck is beginning to work." ♦

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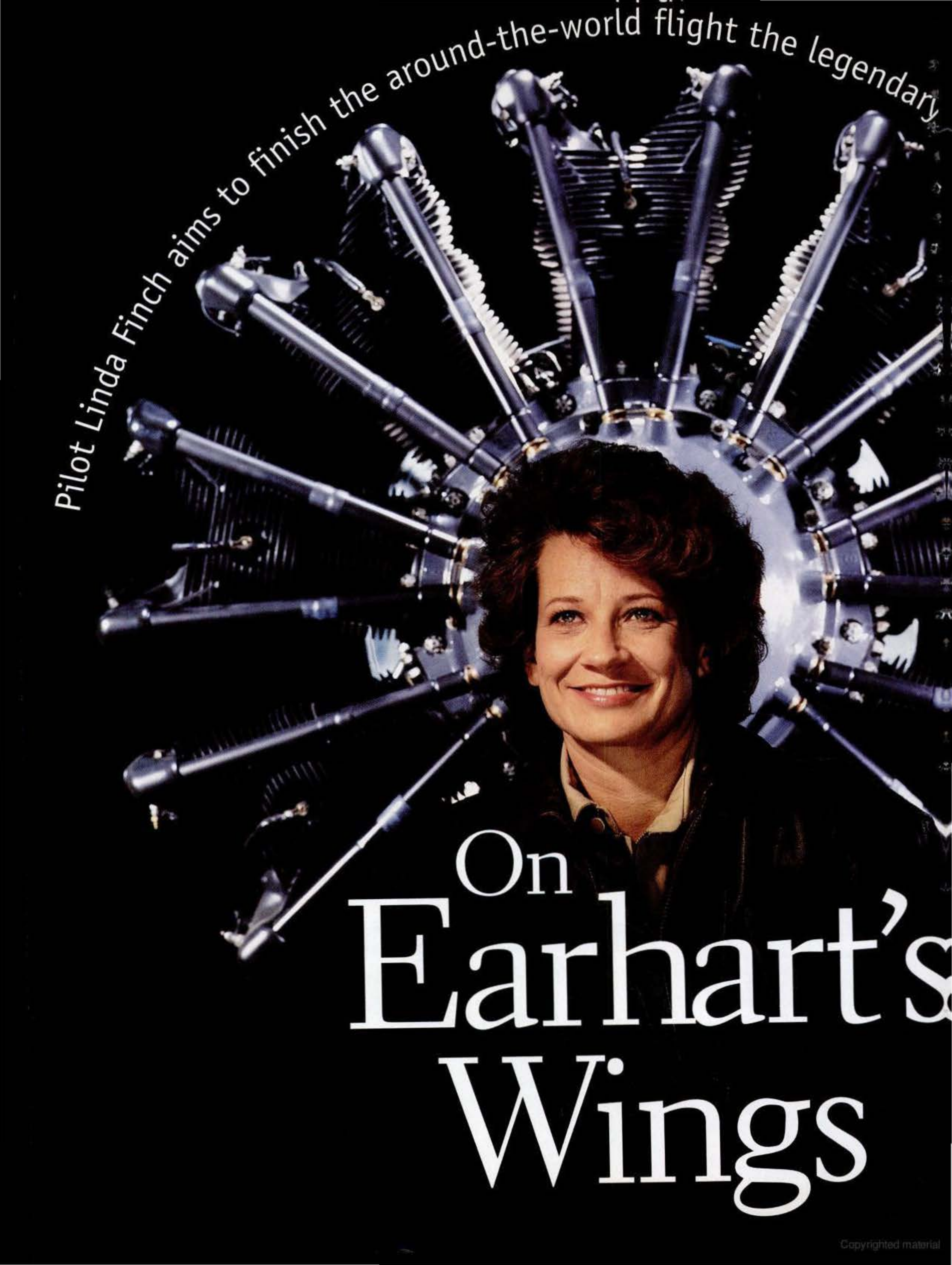
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Pilot Linda Finch aims to finish the around-the-world flight the legendary

On Earhart's Wings

Amelia Earhart didn't.

ON MARCH 17, a ghost plane will rumble down a runway in Oakland, California, lifting off to fly eastward across the southern United States, banking south to Brazil, then continuing across the

By Frank Vizard

Atlantic Ocean and around the world via the equator. With

luck, it should return across the Pacific Ocean to land in Oakland on May 20.

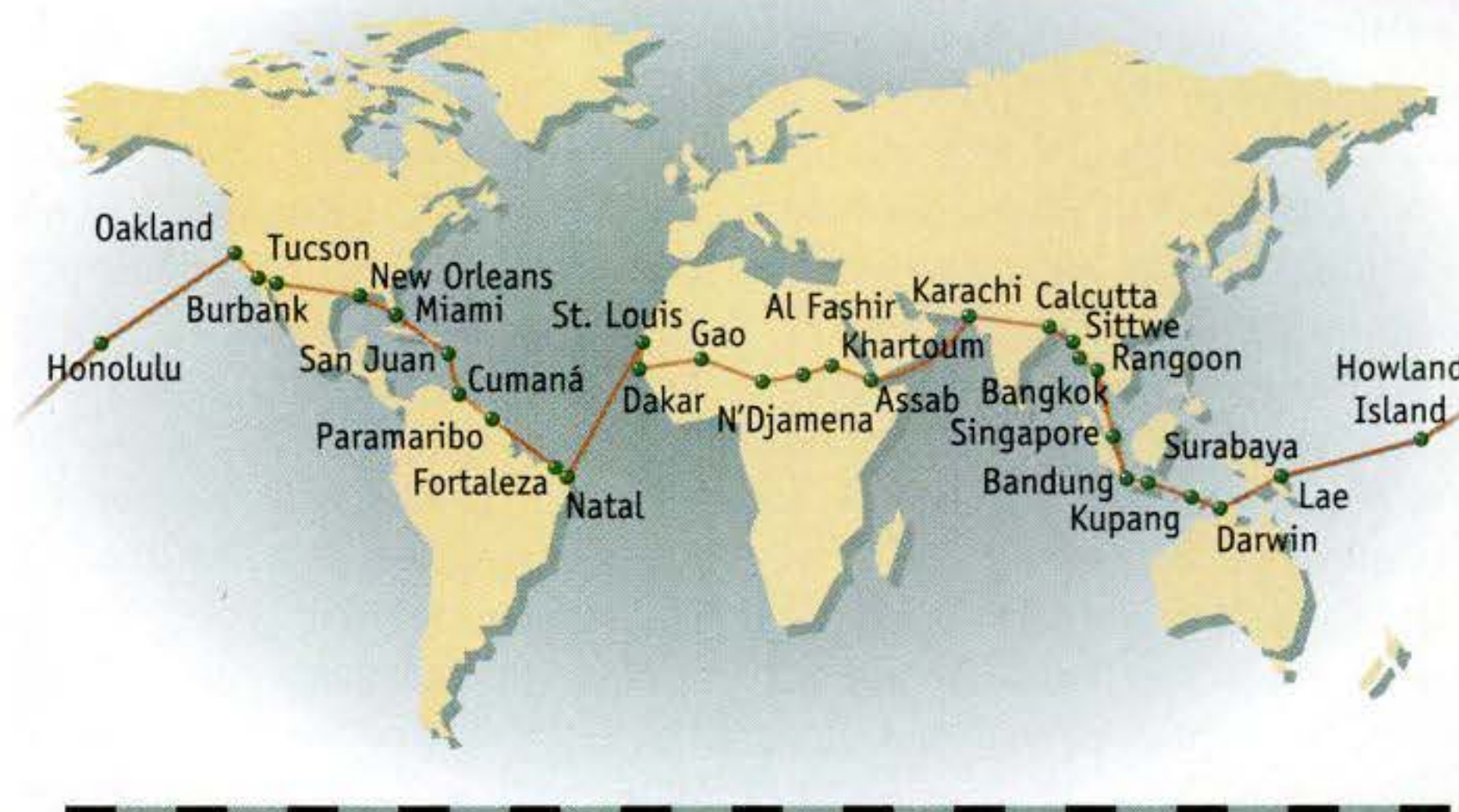
Sixty years ago, Amelia Earhart embarked on the same journey in the same type of plane. She didn't come back.

Earhart's place in aviation history was sealed in 1932 when she became the first woman—and only the second person after Charles Lindbergh—to fly solo across the Atlantic Ocean. By 1937, Earhart was prepared to become the first woman to circumnavigate the globe, around the equator. On March 17, 1937, Earhart took off from Oakland, heading west across the Pacific Ocean.

Earhart's rare Lockheed Electra 10E has a wing span of 55 feet and is 38 feet, 7 inches long.



KEN LICHTENBERG



ALEX REARDON

Pilot Linda Finch, framed against one of two Pratt & Whitney Wasp engines that power her restored Lockheed Electra 10E, will attempt to circumnavigate the globe—finishing a journey that ended for the legendary Amelia Earhart near Howland Island 60 years ago.

PHOTOGRAPHED BY JOHN B. CARNETT

Unfortunately, she didn't get very far. Her fuel-laden plane, a Lockheed Electra 10E, crashed on takeoff leaving Hawaii. Returning to the United States for repairs, Earhart started again on May 21, this time heading east to avoid the hurricane season in the Caribbean.

All went well for 22,000 miles. But on July 2, Earhart, accompanied by navigator Fred Noonan, left Lae, New Guinea, for a Pacific knoll called Howland Island 2,224 miles away. Earhart transmitted her position to a nearby ship with less than 100 miles left in this leg of her flight. Shortly thereafter, the plane disappeared. In the intervening years, Earhart has become a legend, a modern goddess of flight who vanished into the ether and into immortality.

For Linda Finch, Earhart is also an inspiration. Finch is piloting the restored Electra 10E that will attempt to finish the flight that Earhart didn't.

"Earhart lived outside the limits that were set for women in the 1930s," says the 45-year-old Finch, a successful Texas businesswoman and divorced mother of three who has also logged 8,000 hours of flight time in historic aircraft. "She believed that people, including children and men, should have their dreams and work toward them. I felt that by recreating the flight, we'd bring attention to that message again—especially among children. That message clicked with me because I don't like people telling me I can't do stuff either," she adds with a chuckle.

Getting the Electra 10E airborne is already a victory of sorts. Finch's plane is one of two left in the world. Only 15 of the planes, outfitted with massive Pratt & Whitney Wasp engines, were ever made. The planes had been designed for Pan American Airlines for long-distance flights



Earhart, who in 1932 became the first woman to fly the Atlantic solo, felt the Wasp engines had the power to get her plane around the world.

to South America and Alaska.

"These engines are actually larger than those intended for this model aircraft," says Finch. "Amelia realized that this was the only plane that could carry the weight she needed for fuel and that had the power to take off on the short runways she'd be using." The engines alone weigh 650 pounds each and produce 410 pounds of horsepower. Normal range is 810 miles and maximum speed is 202 mph.

The engines are also "horribly loud," says Finch. "The props are about four inches from the side of the fuselage and the air just bangs off it. You can feel the metal vibrating. It's the loudest airplane I've ever been in."

Finch, unlike Earhart, will be wearing hearing protection. She'll have a few other advantages as well. A global-positioning satellite receiver will keep Finch apprised of her position at all times. VHF radio communications will provide help with landings and take-offs. And using a digital camera and satellite transceiver, Finch will be able

to send messages and images for display on the Internet so school children and others can track her progress. (For more information, call 888-317-1997.) Noonan's spot in this epic flight is being taken by a rotating team of four mechanics.

Even with these high-tech aids, flying the Electra 10E is no simple task. "The plane responds slowly to controls," says Finch. "It's like driving a big boat. You turn the wheel and wait." On the plus side, the plane climbs quickly at a rate of 1,140 feet per minute.

With no nose wheel, the Electra 10E can also be a bit unstable during landings and takeoffs, and Finch says it took a bit of time to adjust to that. "Early landings were fine, but they weren't pretty," she notes, laughing.

Then there is Howland Island. Finch expects that leg of the journey to be "eerie." Unlike countless others, Finch has no theories about why Earhart disappeared. "When I get to the part in the story where she is lost, I don't read the rest," she says.

Earhart's disappearance prompts wild speculation. Among the many theories is the notion that she was captured by the Japanese and executed as a U.S. spy—an argument both governments reject. Others say aluminum scraps found on the nearby uninhabited atoll of Nikumaroro suggest Earhart crashed there after running out of fuel.

With a pilot's natural bent toward avoiding ill winds, Finch may not want to dwell on Earhart's fate. On the other hand, she'll take all the good fortune she can get. It isn't lost on her, for instance, that March 17 is St. Patrick's Day and that maybe the luck of the Irish will rub off on her. Will she be carrying any shamrocks? "All I can find," says Finch. "Absolutely." ♦

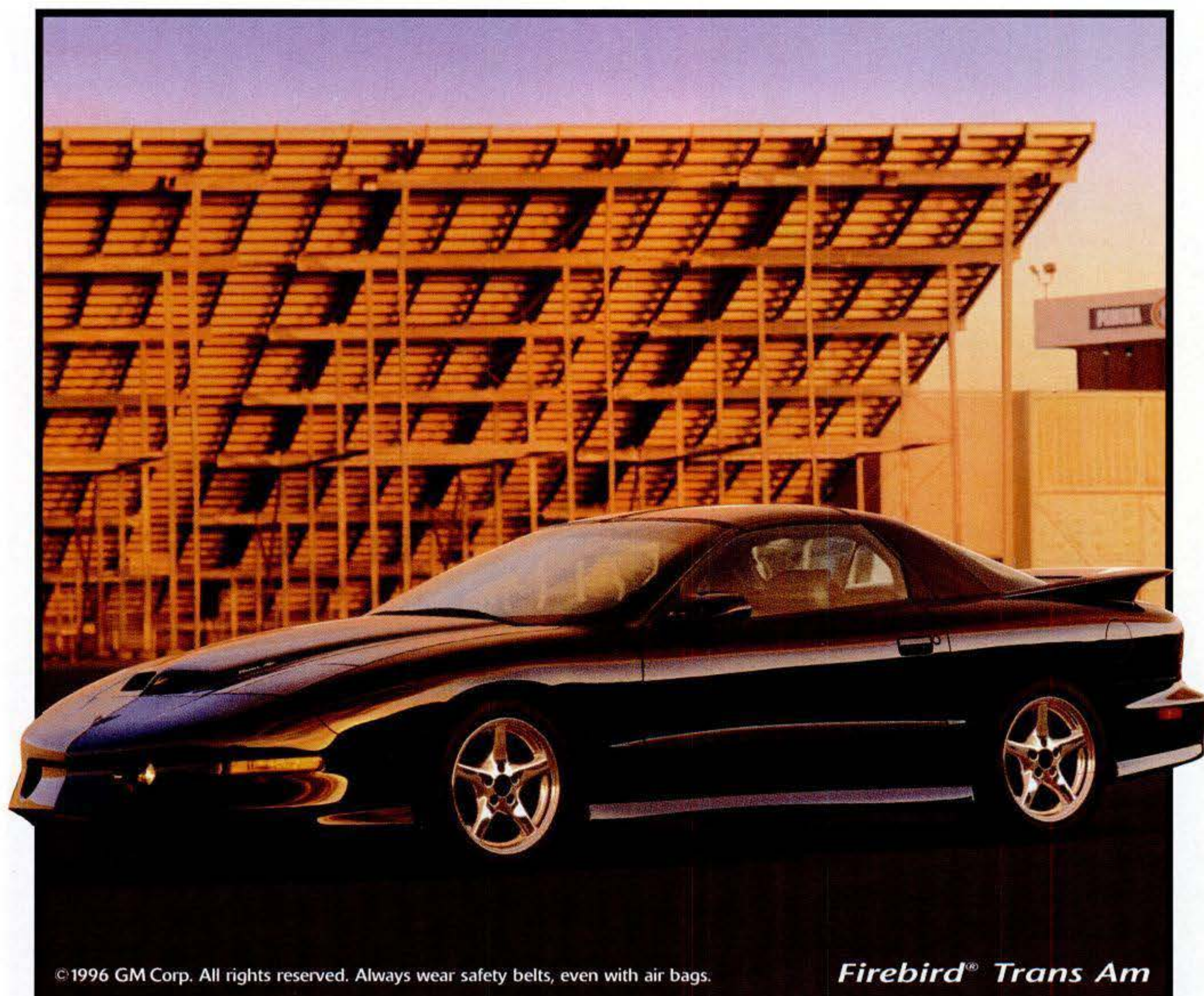
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BLASTING OFF TO BREAK THE SOUND BARRIER ON LAND,
CRAIG BREEDLOVE TOOK ONE OF RACING'S WILDEST RIDES.

By Peter Brock

Black Rock

PETER BROCK

HALFWAY THROUGH the measured mile on the barren Black Rock desert of western Nevada, Craig Breedlove was doing 675 mph, one second away from accelerating past 700 mph and into the unknown. He could see the giant, square, orange mile markers with their integral timing lights rushing toward him, but at the same moment, he could feel the Spirit of



Craig Breedlove contemplates what went wrong, close to the speed of sound.

America starting to go out of control. The air in front of the speeding jet car was becoming incompressible, and shock waves were buffeting the cockpit.

Thin wisps of super-cooled air were forming wave patterns around the nose of his car, and he knew it was time to back off. He hit the kill switch to avert disaster.

At that moment, several equal but opposite reactions took control of Breedlove's car, and he became a passenger on one of the wildest rides in the history of land-speed racing. Wilder even than he had expected in this challenge of one of the last unknown speed barriers—traveling faster than the speed of sound, on wheels.

Since his high school days in Santa Monica, California, Breedlove, an enigmatic 59-year old, has devoted his life to speed. He was 13 years old when he built his first hot rod, and at the age of 23, he installed a surplus jet engine in the first of what would be a series of Spirit of America land-speed cars, and became the first man to exceed 400, 500, and 600 mph. The official land-speed title today is held by Englishman Richard Noble, who 13 years ago ran his jet-powered Thrust 2 to 633.468 mph on the same Nevada desert where Breedlove recently attempted to reclaim the record.

The land-speed record is motor racing's heavyweight division. Essentially, there are no rules. Several years ago, Breedlove experimented with exotic rocket engines to drive his next land-speed car. Amazingly, he had acquired a surplus lunar-landing rocket engine in parts, rebuilt it, and seriously tested it in a totally new car in preparation for an attempt on the land-speed record. Then, the Federal Government banned the transportation of the highly explosive rocket fuel materials on public highways by private citizens, and he had to resort to more conventional means to express his talent.

What followed was the latest Spirit of America, Breedlove's fourth serious streamlined challenger. Breedlove has three goals for this latest car: First, he wants to wrest the title of world's fastest car away from England, reclaiming it for the United States. Next, he plans to be the first man to officially drive an automobile at more than 700 mph. And last, he wants to be the first to exceed the speed of sound on earth.

The Spirit is Breedlove's own personal vision of what a record breaker should be. The gleaming white 44-foot-long car is powered by a highly modified J-79 General Electric aircraft engine that was extracted from a U.S. Navy Phantom jet fighter.

"A stock J-79 produces about 17,000 pounds of thrust," says Breedlove. "We calculated that I would need at least 22,000 pounds to push the Spirit of America to Mach 1." The Spirit's J-79 burns 92-octane

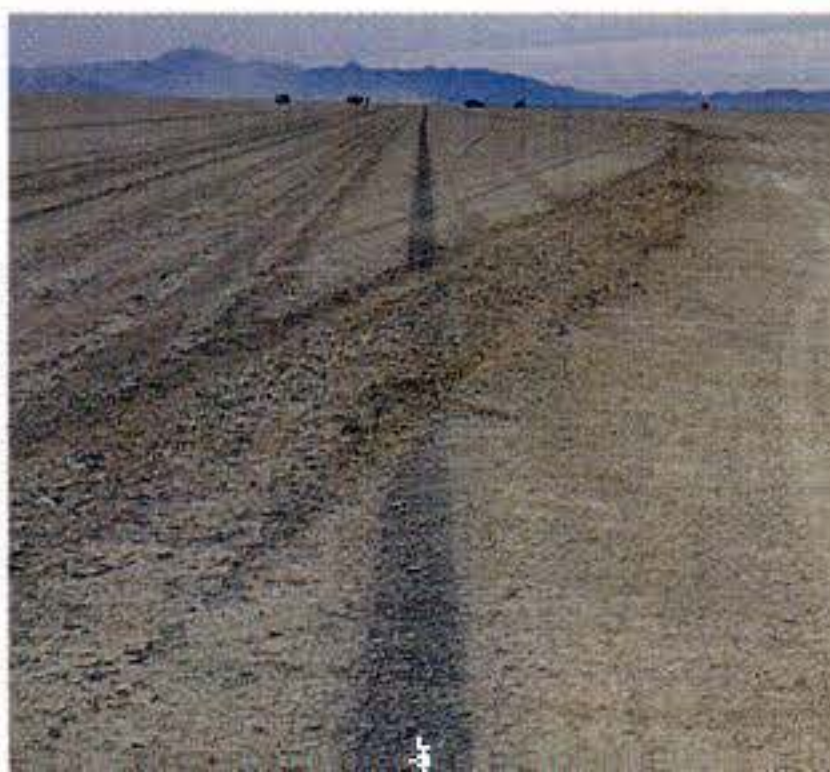
unleaded Shell gasoline. Normally, aircraft jet engines run on JP-2, which is a kerosene blend. Automotive gasoline provides more heat to increase power. "Since our record attempts will last less than a minute each, we could afford to run brief, elevated temperature spikes that would melt a stock J-79," Breedlove says.

The Spirit's chrome-molybdenum tube frame cradles the engine. "The whole structure has to support the engine, fuel tank, and cockpit without bending or twisting even a degree," says Breedlove. "At 500-plus mph, I don't have enough steering input to control or compensate for any deflection." Yet, whole sections must be removable so the engines can be switched or serviced. "It's a real challenge to keep it simple," says Dezso Molnar, the crew chief.

At speeds greater than 600 miles per hour, conventional tire design no longer applies. "Centrifugal forces acting on the surface of even the strongest composite belted tires would cause such a distortion in tire shape that we could no longer consider conventional wheels and tires," says Breedlove. "We had to design a new solid



The track left by the Spirit of America (left) as it veered off the line through the speed traps marks the beginning of Breedlove's wild ride. A rear view of the Spirit (above), taken before the run, shows the placement of the drag chutes and the narrow cross section of the car, barely larger than its jet engine. The rear wheels are supported on narrow, angled steel struts. Breedlove speculated that shock waves formed at the leading edges of the struts could have led to instability.



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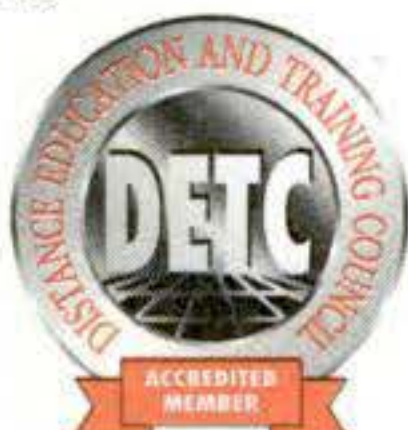
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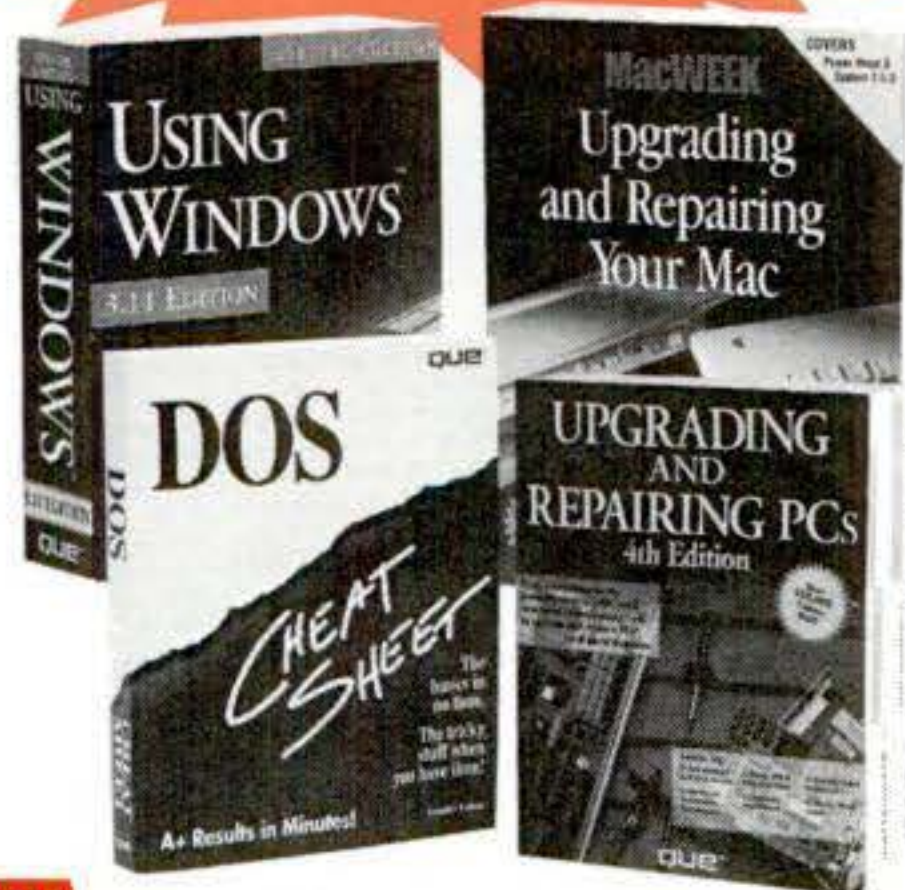


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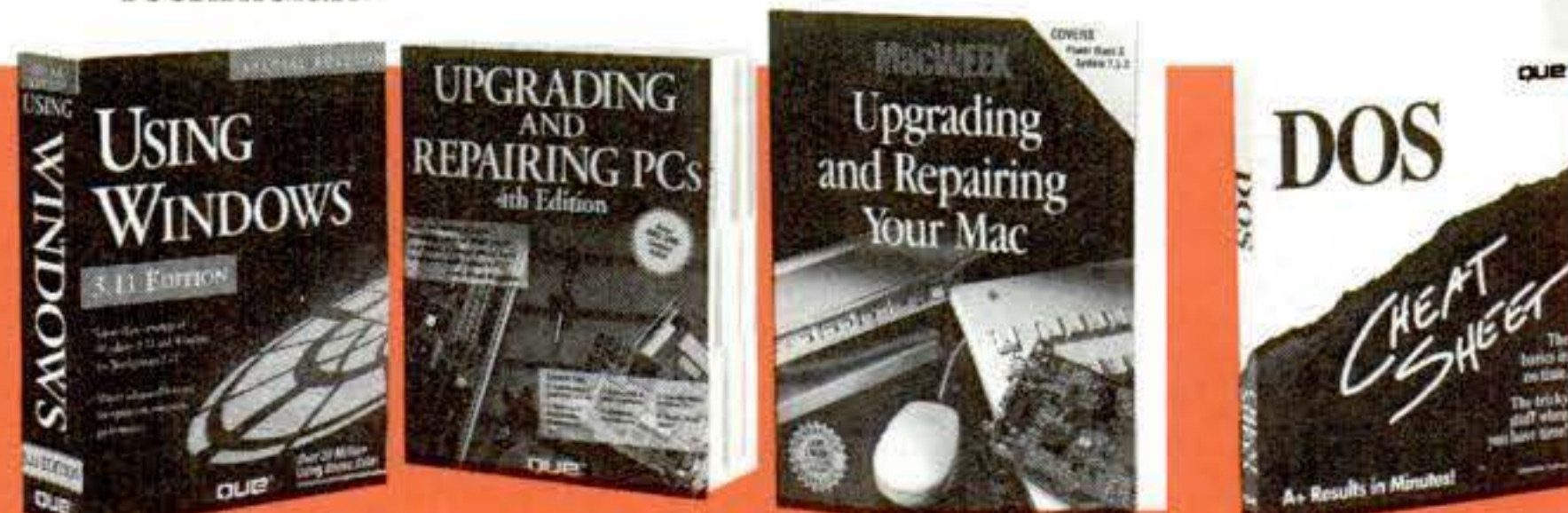
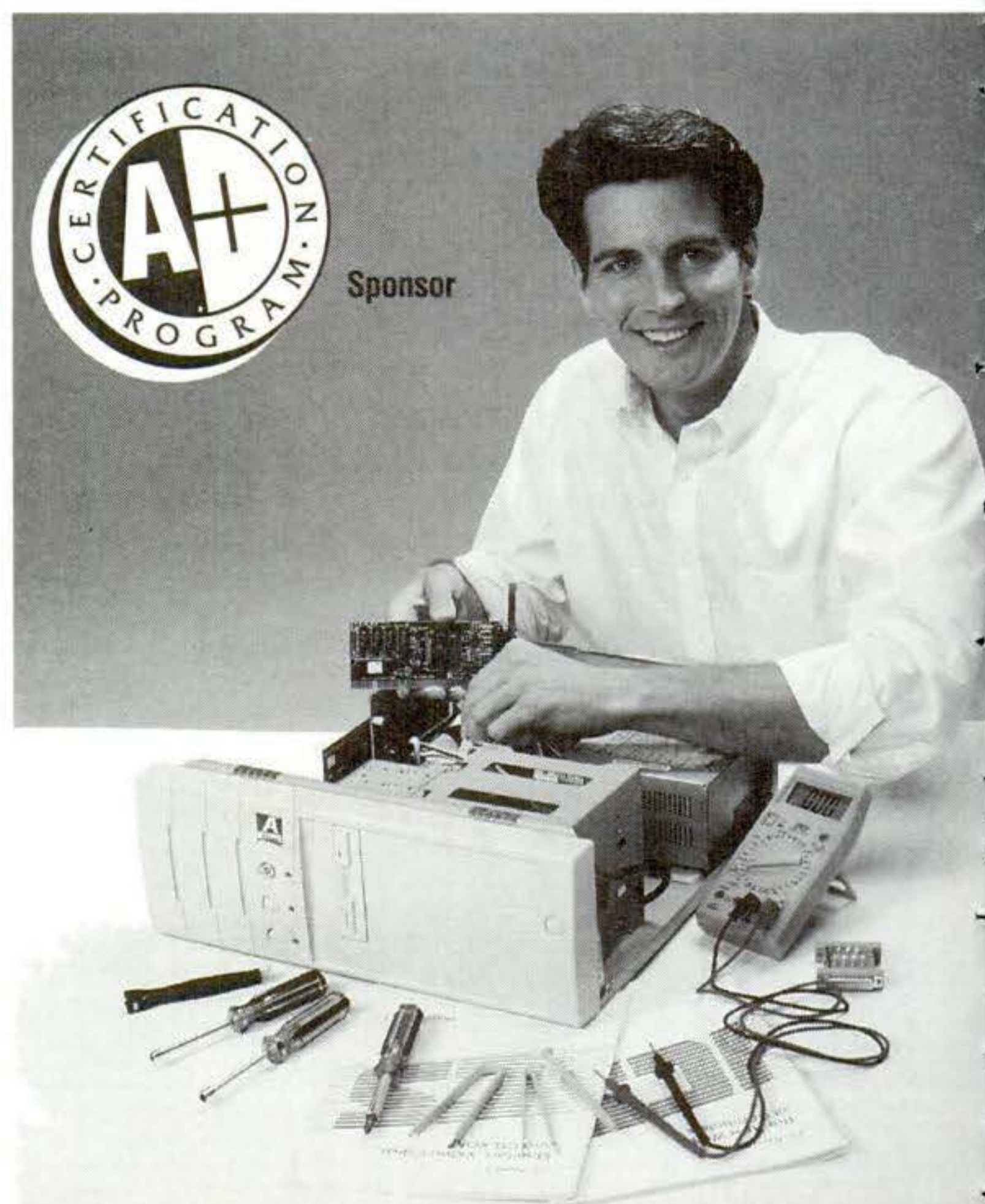
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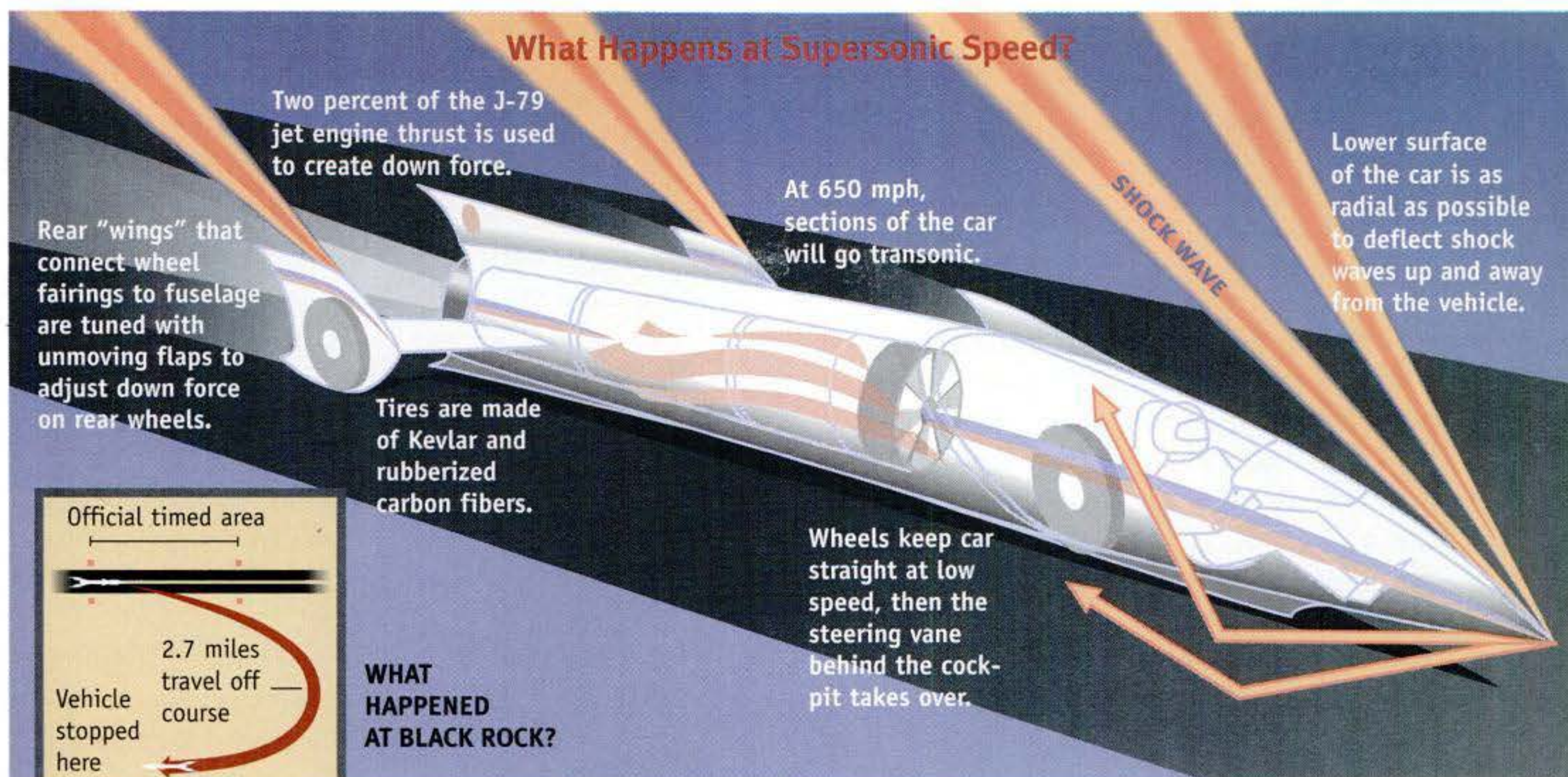
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‘tire’ and matching wheel that were strong enough to support the car at that speed, but would not expand or distort even a few thousandths of an inch, which of course could completely destroy the rear wheel housing.”

The solution was to fabricate a supporting disc capped by “tires” that are specially wound from composite Kevlar and rubberized carbon-graphite fibers. The wheels and the carbon-fiber tires were machined by Stadco in Los Angeles for Centerline Wheels.

Breaking the sound barrier, the ultimate goal for Breedlove’s Spirit, has an archaic ring to it. The sound barrier, after all, was proved to be no barrier at all after a breakthrough in aircraft design 49 years ago, when Chuck Yeager flew the Bell X-1 faster than the speed of sound.

Today, hundreds of millions of dollars worth of research are available to those who seek to exceed the speed of sound, but what is discouraging is that much of the data is worthless. Deciding what applies to an automobile and what is irrelevant is the big issue.

“A shape that is capable of penetrating the sound barrier will deflect **shock waves** off its leading edges, shock waves that are so powerful they can flatten wood-frame buildings,” says Barnaby Wainfan, a leading aerodynamicist who has worked on many supersonic aircraft and has consulted with Breedlove on his new car. “Above the earth, shock waves reflect radially off the front of an airplane at precisely controlled angles. Aircraft designers can control the exact shape and the angle of these shock waves by precisely contouring the shape of the vehicle’s nose and the leading edges of the wings.”

But, Breedlove adds, “No one really knows what will happen when a car reaches the sound barrier, so we can only make intelligent guesses. When we test again next year, we’ll refine the details based on the data we’ve logged. We should be able to predict trends and modify the car’s shape and aero-controls if necessary.”

Perhaps. The problems are speed and reaction time.

At somewhere around 650 mph, sections of the car will go transonic, and shock waves could buffet the car into instability instantaneously—faster than the driver could possibly shut down power or react to correct the condition. Since the Spirit has no driver-controlled correction for pitch, even a few degrees of upward motion in the car’s nose angle, caused by shock waves hitting the ground in front of the car, could launch the Spirit several hundred feet into the air. “We’ll have to ease carefully into that realm,” concedes Breedlove.

The actual construction of the Spirit of America began in 1992, and by March of ’96, Breedlove’s team had completed the first reworked J-79 for static tests. With water injection and the afterburner on full throttle, the team’s test engine sustained 22,650 pounds of static thrust in the Aero Turbine test cell at Stockton airport in California. That’s equivalent to 45,000 horsepower.

The official land-speed record is an average of two timed runs through a precisely measured mile/kilometer speed trap, over the same course within an hour’s time. A six-mile entry leads into the timed mile/kilometer trap, followed by a six-mile deceleration zone. For additional safety, there is another safety zone of at least two miles on each end of the course, in case of parachute or brake failure. After the car’s first official run, the crew has one hour to refuel and service the car to make the return pass.

A place that is long, straight, and flat enough to attempt the feat is not easy to find. Bonneville Salt Flats in Utah has been the site of several land-speed record attempts, and Breedlove conducted some preliminary testing there. But the Bonneville course is steadily shrinking as the brine is pumped from its surface.

An alternative is the Black Rock desert, a starkly beautiful dry lake some 120 miles northeast of Reno, Nevada. The slightly cracked dry clay surface of Black Rock provides better traction than the slightly damp surface at Bonneville. The Black Rock dry lake is probably the

best place in the world to attempt a land-speed record.

Breedlove is distant, quiet, and focused when he arrives with his crew to make a serious attempt at a record with his new jet car. All that matters now are the car, the weather, and the time. When it is late in the season, even light rains can disturb the lake's carefully prepared surface without warning—and a day's work can be erased in a couple of minutes. "You gotta go when you can," says Breedlove.

In the Spirit of America's first six test runs, the car's stability encouraged Breedlove to raise his speed incrementally for each run.

But now, on October 28, he had run out of time, weather, and finances. His first test run that morning, in ideal conditions, had gone badly. A malfunction of the fuel flow on the afterburner had limited the morning's speed to 477 mph, well below the 640 mph needed to reclaim the record. It was important to attempt another run as quickly as possible, so that if he broke the record in one direction, he could race again in the opposite direction within the hour to make it official.

Delays in solving the fuel-flow problem kept eating at the time window. He couldn't wait another day—weather experts predicted rain and snow by the evening. At the starting line on the north end, there was little evidence of wind, but six miles south, down the course, the 10-degree crosswind had increased to 11 mph.

Breedlove strapped in and went for it. The J-79 was spooled up to full power, and then the afterburner was ignited. The Spirit of America accelerated for four miles, all the way to the speed trap. By the time he had reached the electronic eyes to officially verify his speed, Breedlove knew he would have to make a critical decision. His feel of the car told him it was going into the critical transonic range. If he held full power through the traps, it might be too late to recover control. A jet under full afterburner power cannot be throttled back or eased off.

He killed the power to the J-79 and the car became unstable. The front wheels were barely touching the lake bed, and the interconnected aerodynamic dorsal steering vane on top of the cockpit was not large enough to control the car's direction.

Without a crosswind, Breedlove might have sailed through the time traps safely, but the crosswind pushed the Spirit's nose off course. Afterward, Breedlove noted that the rear of the car might have been lifted by a transonic shock wave. The Spirit missed the huge orange trap markers by a few hundred yards and was soon cutting a giant U-turn in the lake bed that would eventually take the car 1.6 miles off its intended course. Halfway through the wild U-turn, centrifugal force rolled the Spirit's fuselage up 30 degrees on its left side. The car was now riding on

the side of its needle nose, the fuselage just behind the air intakes and the left rear wheel fairing. It continued to scrub off speed as it went on around, completing a full 180-degree arc, again facing north, before it eventually dropped back onto its wheels. Breedlove attempted to deploy both braking chutes, but only one fired. The electrohydraulic ski brake beneath the fuselage burned off the last few remaining miles per hour and Breedlove came to a safe stop, personally unscathed.

The Spirit, although almost totally intact, had suffered considerably. Both rear wheel supports had been severely strained and had pulled through the skin at the fuselage attach points. The engine had eaten enough lake dust to start a small farm, and would have to be completely disassembled before it could run again. Breedlove had been fortunate—the damage could have been much, much worse. He had given everything he had to re-establish his presence as a world record contender and had come within a few seconds of being the new title holder.

The crash at Black Rock delayed but didn't deter the effort to exceed the speed of sound on land. The Spirit had proved it was capable of capturing the record—now the quest will be a race for good weather, among several contenders. As Breedlove completed his run, Noble was loading his new car, the twin-Spey-engined Thrust SSC, aboard an aircraft to head for the Middle East. King Hussein of Jordan offered his 10-mile paved military runway in the Jordanian desert for Noble's attempt. A few weeks later, rains washed out that effort. Breedlove could challenge the record in a month or two in Australia, but at this time, the plan is to run next summer in the United States.

The challenge and the danger create their own kind of camaraderie that transcends competition. Englishman John Ackroyd, the designer of Noble's record-holding Thrust 2, came to Black Rock this year to assist Breedlove in setting up the course on the lake and to provide whatever expertise he could. Asked what's different about the Americans and English and their methods in their quests for the world's record, Ackroyd is quiet for a moment and then replies. "It's the culture. In America, your drivers are more hands-on, designing and building their own cars. In England, wealthy men like John Cobb, Malcolm Campbell, and Richard Noble have traditionally hired others to design, engineer, and fabricate their cars. Cobb, Campbell, and Noble were gentlemen racers. Drivers like Craig Breedlove and the Arfons brothers, who challenged Craig in the '60s, have done it on their own in their backyards with bits gathered from wrecking yards and obsolete military aircraft. It's fascinating."

"This is a strange business," he says, "I couldn't very well stay away, could I?" ♦

The future of high performance at Chevrolet
is hidden under the skin of the new Corvette.



A NEW CORVETTE comes along about as often as a new Pope—once every 10 or 12 years. The 1997 Corvette represents the fifth time in its 44-year history that America's sports car sweetheart has

By Don Sherman

had a major makeover. It is a watershed long-anticipated by sports car enthusiasts and automotive technophiles alike, as reports leaked out that GM was considering a radical change in an American icon, or even dropping it altogether.

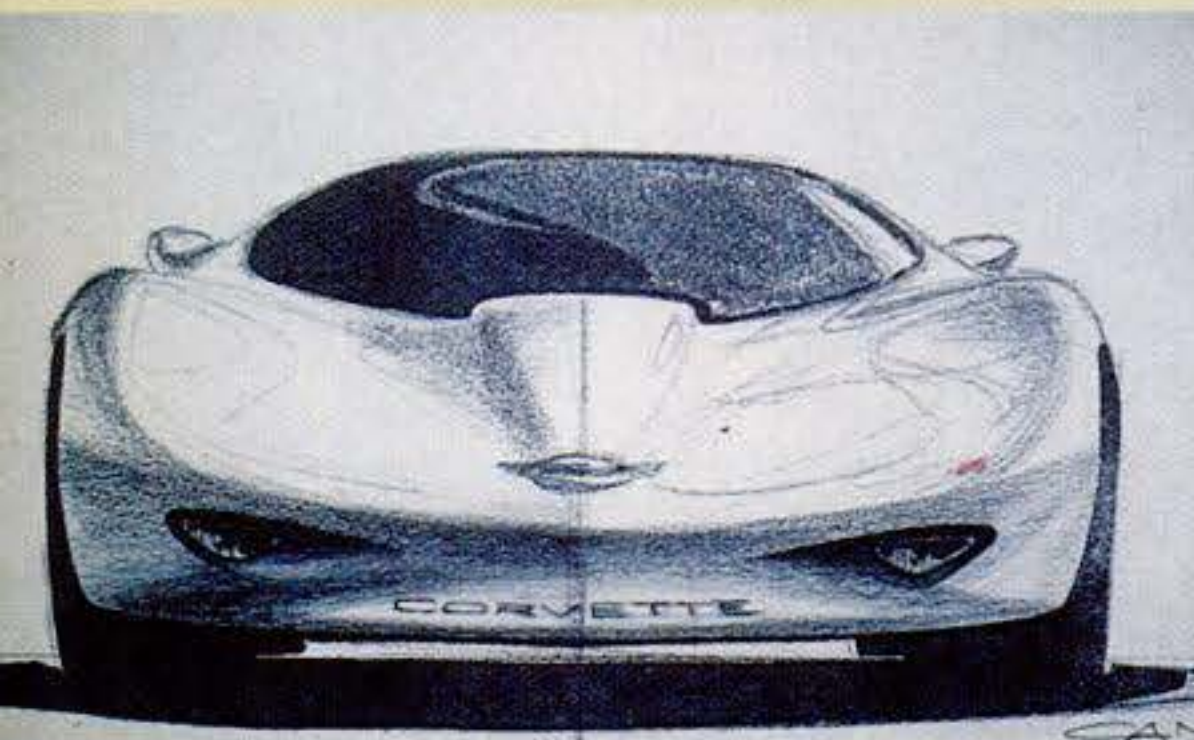
For their patience, the faithful have been rewarded with technology that vaults ahead by leaps and bounds.

The latest Corvette, now arriving as a late 1997 model, is revolutionary in every way but exterior design. There's a remarkable

The Corvette that Never Was

BY JIM SCHEFTER

BY THE TIME the first shots in the Battle of the Mid-Engine Corvette were fired on March 1, 1991, a new Corvette was long overdue. The car on the road in 1991 had been designed in the late Seventies and first produced for sale as a 1984 model. Its replacement originally was to be a 1993



Two early ideas for front-end treatments capture the theme of the classic long-nose Corvette shape.



model, but delays made the dream take on a Rip van Winkle aspect, and after a dozen brushes with death, the all-new Corvette was not to be launched until January 1997.

In the course of shaping the new car, scores of would-be Corvettes had been carved into clay models. All of them had common assumptions: The next-generation Corvette would be new, but not radical in looks. And most of the new designs assumed that the new Corvette would still be front-engine and -transmission, with rear-wheel drive.

When the first Corvette was built, rear-wheel drive was the American standard. By the mid-1970s, front-wheel drive was

Adapted from the forthcoming book, *All Corvettes Are Red*, ©1996 by Jim Schefter, to be published by Simon & Schuster.

engine under the hood. The powertrain layout is unique. The structural concept is innovative in its use of advanced materials. The 1997 Corvette may lack something in terms of punctuality, but it more than makes up for it in originality.

A light, high-tech engine...with pushrods?

GM rarely introduces an all-new engine with an all-new car, but that's merely one of the cardinal rules broken by the 1997 Corvette. Another surprise is the use of a pushrod valvetrain in an engine for the 21st century.

All manufacturers eventually confront a philosophical fork in the road toward future powertrains. One choice is overhead cams and multivalve combustion chambers. The other path is the traditional pushrod, two-valve approach. So far, General Motors is the only maker to split its resources by taking both paths.

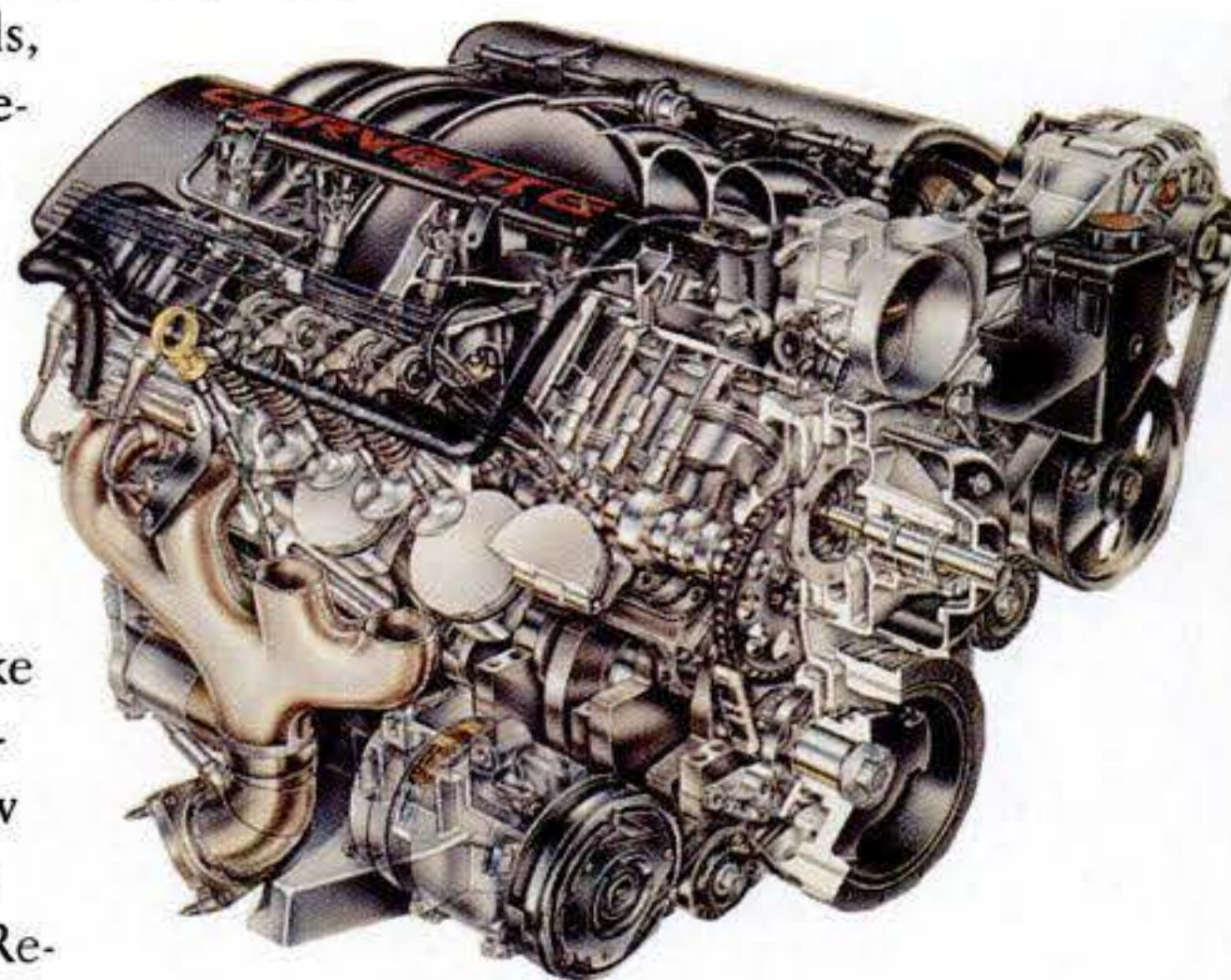
John Juriga, product manager for the Corvette's new LS1 V8, says that his team could have chosen any engine design that met ambitious performance goals. The pushrod approach was selected because goals were met or exceeded with an engine significantly smaller and lighter than one with four overhead cams, and at less expense.

The LS1 is a 5.7-liter V8 sharing but one key dimension—inter-cylinder spacing—and a couple of minor parts with Chevrolet "small-block" V8s of the past. Major new features include a deep-skirt block, rearranged intake and exhaust passages, advanced electronic systems, and weight-saving materials. Extending the cylinder block well below the crankshaft's centerline results in a much more robust structure that's less likely to radiate noise and vibration to the Corvette's passenger compartment.

The quest for high volumetric efficiency (good breathing), efficient combustion, and high-rpm durability has driven most manufacturers in the DOHC direction. To achieve all these ends without the extra bulk, weight, cost, and the complexity of multiple cams and valves, Juriga's team was particularly creative in the valvetrain and cylinder head areas.

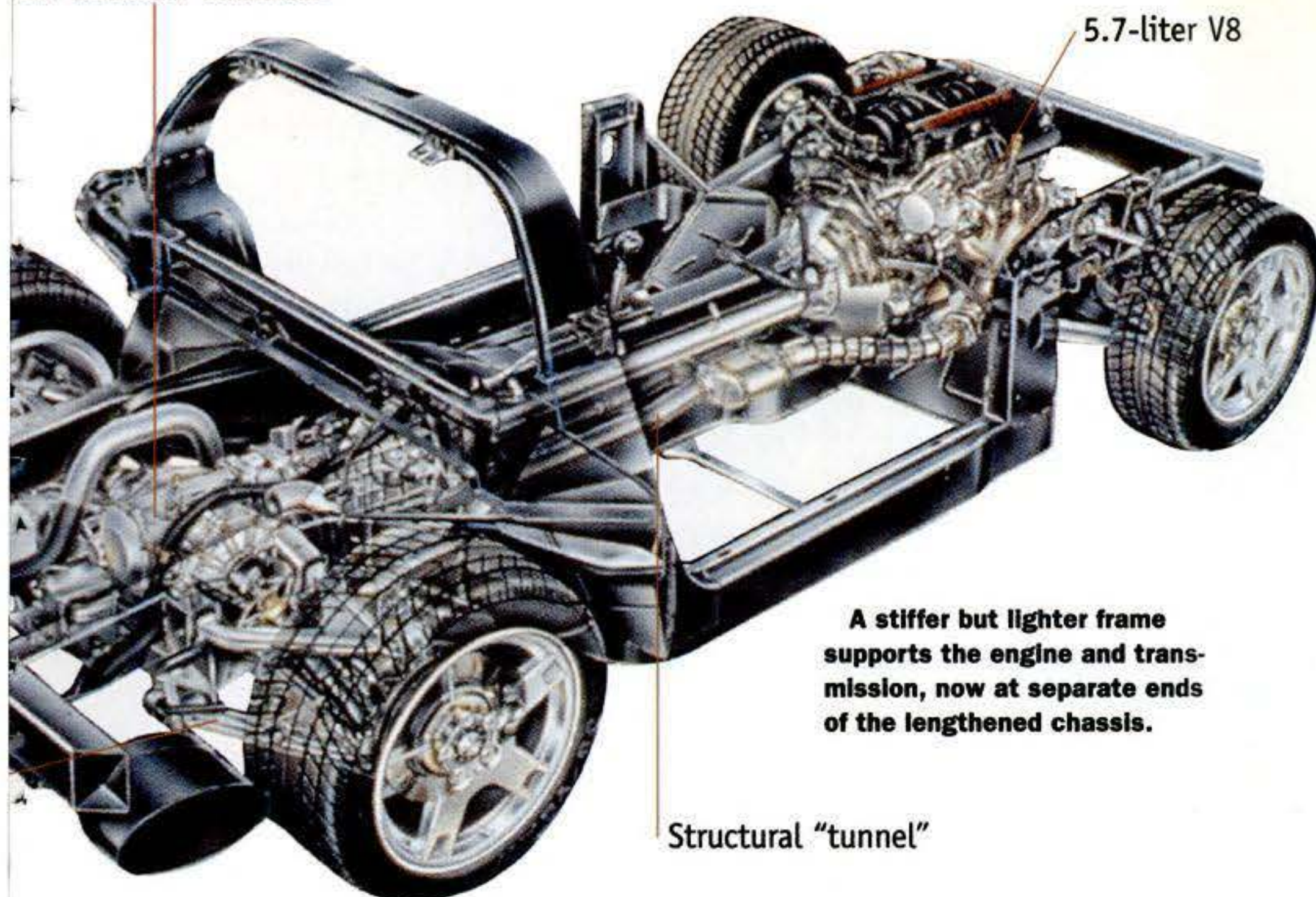
Normally, pushrods, head bolts, and intake-ports all fight for the space available between banks. To ease congestion, the new Corvette V8 has eight fewer head bolts. Instead of crowding two intake ports between adjoining pushrods, the new LS1 layout alternates ports and pushrods. Redesigned intake passages are tall and thin to provide sufficient cross-sectional area for excellent flow without taking up excessive space.

The new 5.7-liter LS1 V8 delivers a maximum 345 horsepower at 5,600 rpm and significantly more torque between 2,500 and 5,500 rpm. The use of an aluminum block and a



The new 5.7-liter Corvette engine mixes innovative materials and technology with a traditional pushrod valvetrain.

A-arm rear suspension



A stiffer but lighter frame supports the engine and transmission, now at separate ends of the lengthened chassis.

molded-nylon intake manifold helped trim 55 pounds from the weight of the previous Corvette engine.

Engine and transmission go separate ways

The 1997 Corvette honors long-standing traditions with the engine in front and the drive wheels in back, but in between there's major upheaval. To facilitate a new backbone frame concept, the transmission has been shifted 54.1 inches rearward and integrated with the differential to create a new transaxle assembly.

The use of a transaxle is standard practice with front-wheel-drive and mid-engine applications. What is unusual is placing the gear boxes (both a six-speed manual and a four-speed automatic) ahead of the differential instead of behind it. Doing so required an 8.3-inch increase in wheelbase to leave sufficient passenger space. This innovative layout was selected because it allowed the use of existing transmission hardware: GM's Hydramatic 4L60E automatic and a stick shift supplied by Borg Warner (also used in the Camaro, Firebird, and Viper). The differential is a new GM design manufactured by Getrag.

A long aluminum torque tube provides a rigid connection between front and rear powertrain modules. This five-inch-diameter structural member contains a 2.2-inch driveshaft made of metal matrix composite material (a high-strength aluminum alloy containing aluminum-oxide particles).

Keeping it together

Structural stiffness is every maker's Holy Grail these days because a firm foundation is the righteous path to a smooth, quiet car. The interior is less likely to develop squeaks and rattles with age. The suspension can be tuned to do a better job of handling bumps and curves when it's securely anchored.

The previous approach used two tall frame members running below the door sills, tied together by crossmembers. But what this lacked in structural efficiency, it made up for in entry difficulty: Climbing aboard a 1984 through 1996 Corvette was only slightly easier than strapping into a military jet-fighter.

The new design uses a large stamped-steel tunnel down the

fast becoming the norm for sedans, but high-performance American cars stayed with a large-displacement, front-mounted V8, and rear-wheel drive. Meanwhile, many race cars seeking maximum traction and braking capability had shifted to designs with a midship engine, close to the center of gravity, powering the rear wheels. Many new sports cars that were headed for the track followed suit, and a wide variety of manufacturers, from Ferrari to Toyota and even GM's Pontiac division, introduced mid-engine sports cars.

But a new structure for Corvette was lurking in the background. It would have a sturdy backbone down the center of the car, and one-piece side rails of great strength. The structure was radical in a way that Corvette lovers would accept, but it wasn't mainstream. Not yet.

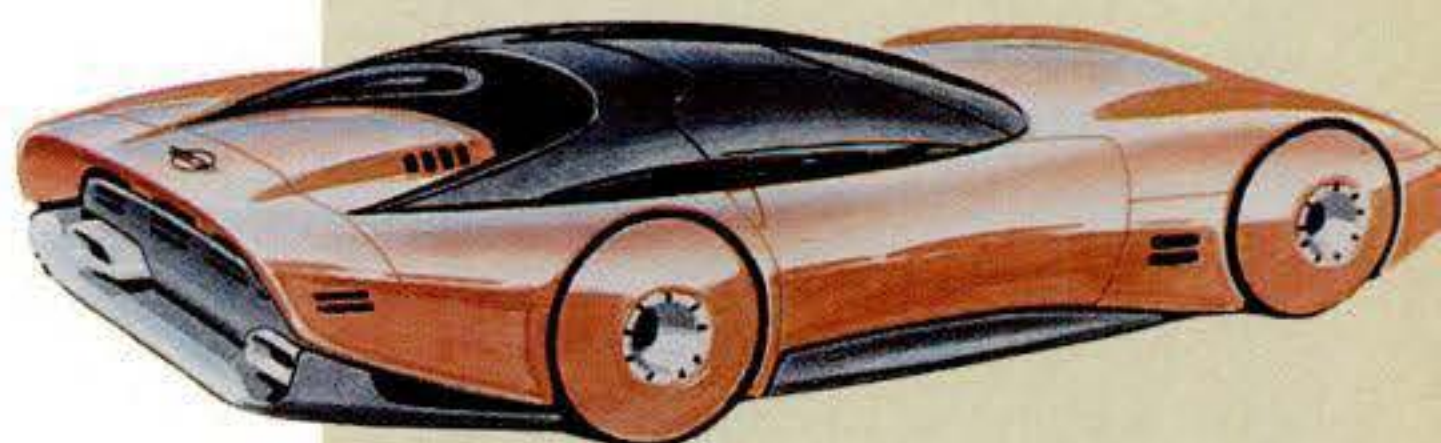
The job, to design a Corvette to fit over the current structure, and to dabble with bodies that might fit over the backbone, should have been easy. But, the stop-and-start orders inflicted on Corvette between 1989 and 1991 left the development



A mid-engine Corvette would have allowed designers to slope the front end steeply.

group with a case of psychological whiplash and let a different kind of car slip into the fray.

There were several main players in the drama. John Cafaro was the lead Corvette designer. His studio was to style the car, while chief engineer Dave McLellan's people handled the technical side.



A radical design followed the front-engine layout but was not practical for a production car.

Neither side was prepared for the internal conflicts that were to come.

Design vice president Charles M. Jordan was the catalyst for turmoil. In 1989, he'd

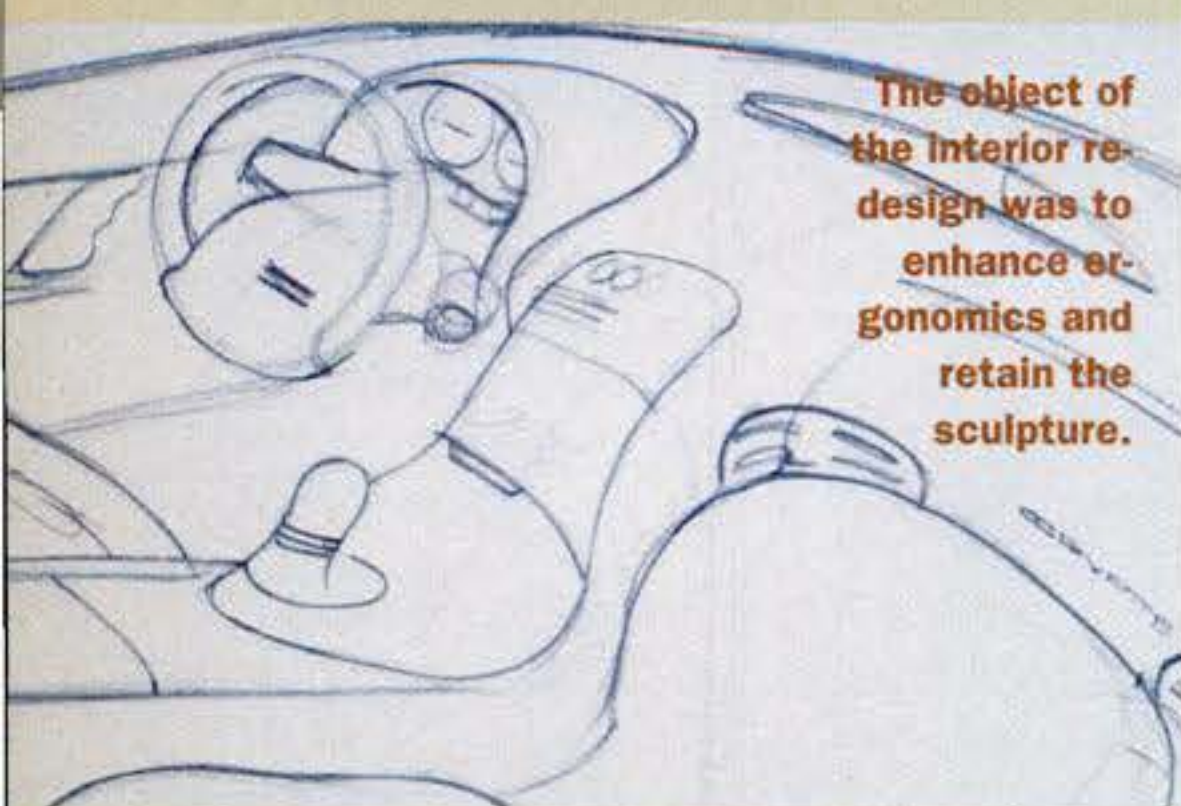
disliked much of what he saw in Cafaro's studio and ordered a new design. The result, called Stingray III, was a radical little car with cat's-eye head lamps, low-slung lines, and feline beauty.

"Don't copy it," Jordan told the artist and his crew. "That's not the car I want. It's not perfect. But it's the standard. I want you to beat it."

Cafaro set out to do that. In mid-February, he and his staff took a full-size clay model outside for a daylight preview. Jordan didn't like it. "It looks a little Chrysler-y, kind of Viperish," said another executive. Cafaro bit his tongue in silence.

This time, Jordan ordered his own engineering staff to ignore both the standard Corvette structure and the backbone still being analyzed.

Instead, they'd go with mid-engine designs, with the motor sitting directly over the car's center of gravity. That put the engine behind the driver, a configuration favored for very high-performance cars and many purpose-built race cars, because the concentration of weight at the center of the car reduces the inertia that resists quick turns. One drawback, notes a Corvette engineer, is that its quick response can make a mid-engine car



The object of the interior re-design was to enhance ergonomics and retain the sculpture.

difficult to drive in slippery weather.

For stylists, a mid-engine layout opens multiple avenues of design. Front ends can swoop and sweep without an engine block in the way.

In GM's design department, dozens of additional Corvette models took shape. Many were mid-engine, ranging in looks from spectacular to garish. Some were traditional. And a few of the designs were being draped over the backbone structure that was looking better and better to McLellan's engineers.

The "backbone" structure that looked

middle of the car, augmented by one lower-profile frame rail at each door sill. Bolt-on aluminum crossmembers beneath the engine and at the rear provide both lateral reinforcement and secure steering, suspension, and driveline mounting locations.

Outer frame rails are made with an innovative technique called hydroforming. An 18-foot-long piece of six-inch-diameter



The new frame rails are made efficiently in a press that uses high-pressure water to form them in a closed die.

ter steel tubing is first bent to rough shape and then loaded in a press containing an upper and lower forming die. The press closes the die halves, and hydraulic pressure forces the tube to conform to the die cavity's inner contours. After removal from the press, each tube is trimmed to length and welded

to other components that make up the Corvette's structure. Fourteen separate pieces were used to make one frame rail previously, so the new approach represents a significant savings of weight, cost, and complication.

Like the previous Corvette, the new car's suspension is aluminum-intensive. Control arms of unequal length—used in front since the 1953 original—are back for another round. A similar approach is employed at the rear for the first time. As with the previous generation Corvette, transversely mounted fiberglass-reinforced leaf springs are used front and rear. Goodyear Eagle F1 GS Extended Mobility (run-flat) radials are standard equipment, eliminating the need for a spare, jack, and tools.

One magnesium casting and several aluminum extrusions support the instrument panel, windshield, steering column, and pedal assemblies. Floor panels use sandwich construction—balsa wood between two layers of fiberglass—for maximum stiffness and minimal weight. Despite the ambitious and intelligent use of modern materials, the new Corvette is no lightweight: It tips the scales at 3,200 pounds, a mere 75 pounds less than the previous iron-cylinder-block car.

The nervous system

The new Corvette's nervous system is a state-of-the-art array of advanced electronics. Multiplex wiring permits some two dozen microprocessors to instantly share key operating variables (engine rpm and road speed, for example) in the form of coded messages on one party line.

Under the hood, eight computer-controlled ignition coils



The lengthened wheelbase and rear-end redesign increase room in the trunk.

eliminate the distributor. A "drive-by-wire" system operates the throttle to combine cruise- and traction-control functions while eliminating mechanical linkage. Optional shock absorbers sense wheel travel to shift quickly and continuously between soft and firm damping limits. A cockpit knob permits selecting between tour, sport, and performance modes.

Behind the wheel

All this new technology produces incremental gains in every category, from fuel efficiency to stopping distance. But what's more remarkable is a new user-friendly personality.

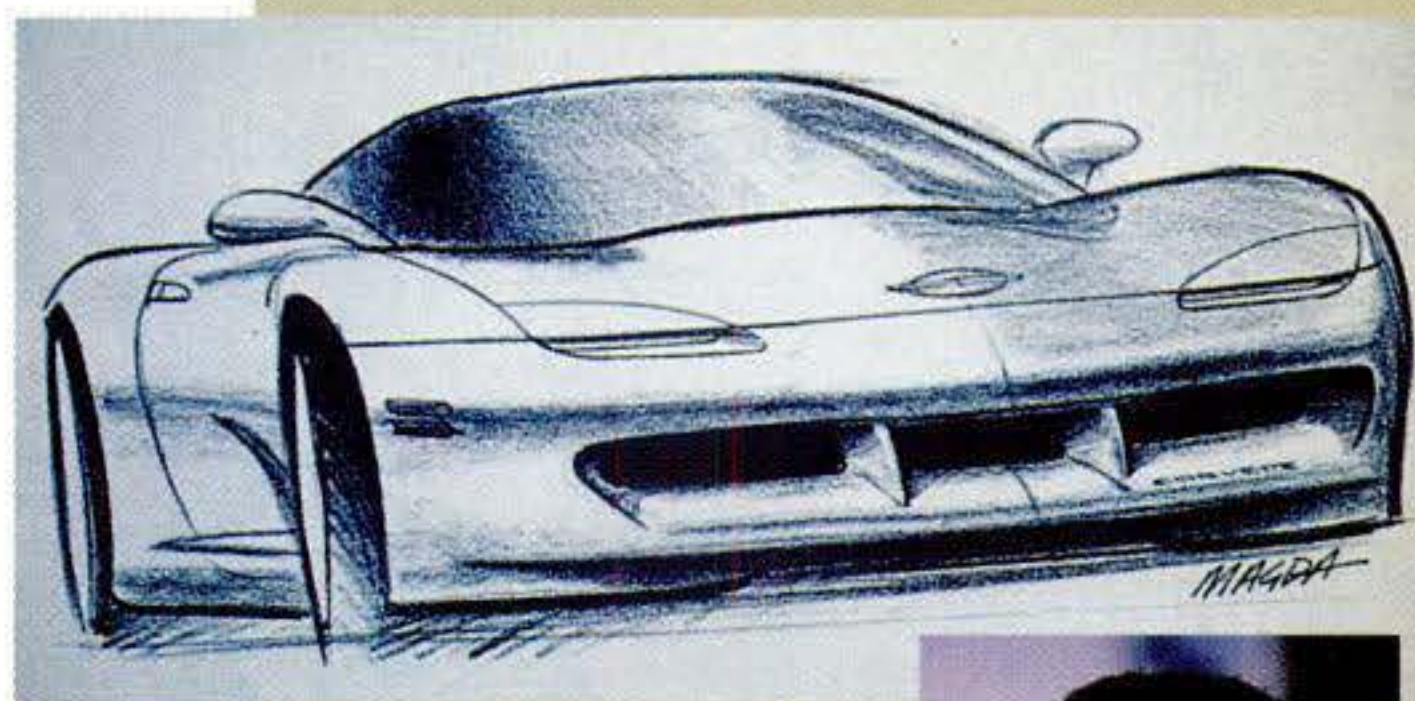
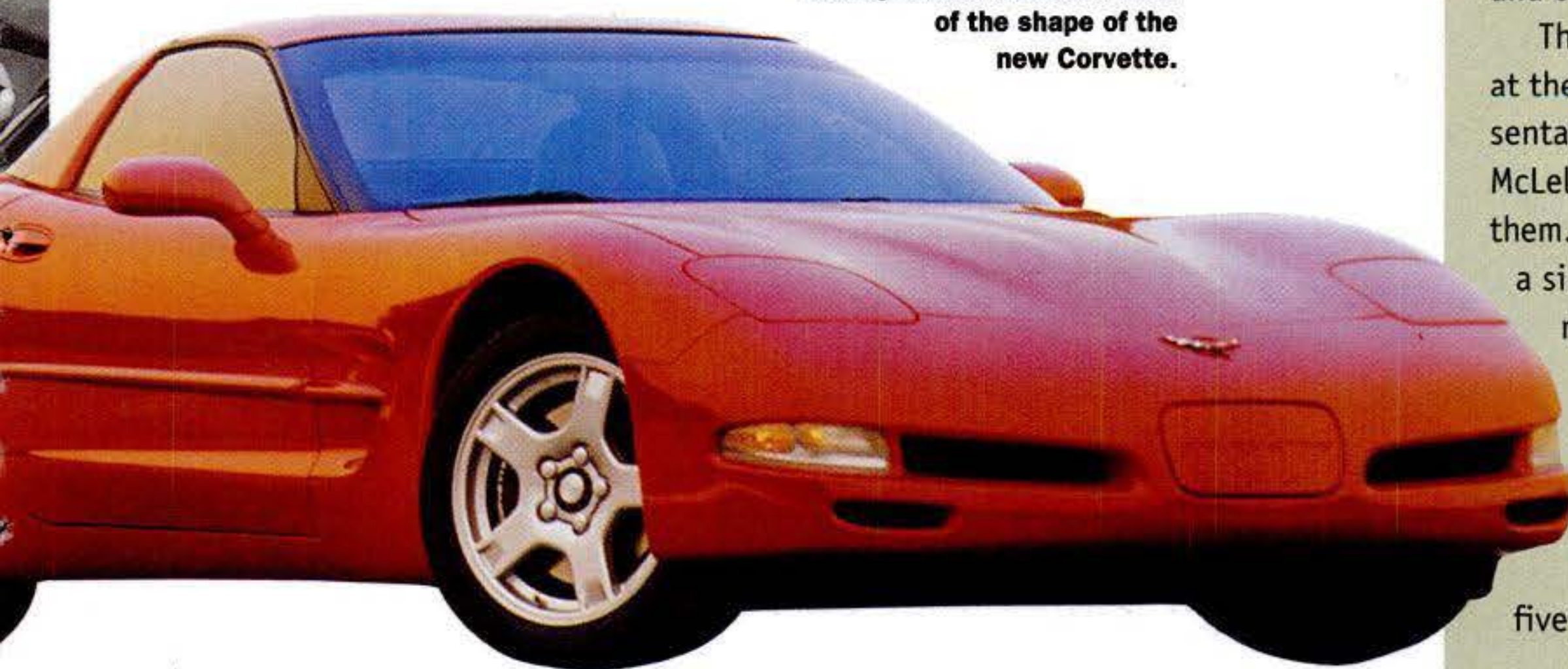
You can hop in, latch your seat belts, and enjoy a pleasant commute if you don't feel like taking advantage of the car's 172-mph top-speed capability. The cockpit is a roomy, quiet, and comfortable place. Storage areas are handy, and the cargo hold is much more accessible and twice as large as before.

The car's road manners are poised, without the punishment that usually accompanies a stiff-legged sports car. Relocating the wheels to the Corvette's extremities (for a longer wheelbase and wider tracks) has paid off with major dividends in stability. There's gentle understeer (front tires sliding) at the limit of adhesion entering a turn, and manageable oversteer (rear tire drift) when you boot the throttle while exiting a bend. Dive and roll during braking and cornering are practically nonexistent. The speed-sensitive steering is quick and more communicative than any Corvette of the past.

The new LS1 engine—arguably the least progressive part of the car—happens to be one of the new Corvette's most endearing attributes. Step into the throttle with the tach needle lagging and your solar plexus promptly reports pleasurable forward thrust sensations. Gas the new Corvette with the needle at the high side of the dial, and your eye will instinctively check the rear-view mirrors for ominous signs of red. The LS1's mellow tenor tones are so richly refined that they deserve their own special performance at Carnegie Hall. Forget about the push-rods, this Corvette has a heart of pure gold.

Is the new Corvette worth the long wait? Those anxious for breakthrough styling or major gains in test-track performance may now register their disappointment. But for everyone else who's interested in the best all-around two-seat sports car that (approximately) \$40,000 will buy, your Corvette is ready. ♦

Aerodynamics dictated much of the shape of the new Corvette.



John Cafaro is the designer who took the Corvette through its changes on the drawing board, from radical, to mid-engine, to the final, aerodynamic shape.



so appealing left the engine in front, but moved the transmission to the rear of a structural tunnel down the middle of the car. The shape that resulted retained the long hood and short rear deck of the traditional roadster.

In late 1991, platform manager Cardy Davis convened a group to analyze the various proposals for the new Corvette. In the end, they'd all vote on Corvette's future.

A conventional approach to the redesign dominated the early thinking of GM's design staff.



It was a setup.

But nobody needed to rig the data. Davis already knew that the mid-engine Corvette couldn't survive the financial and technical challenges it would face.

The vote came on January 28, 1992, at the end of exhaustive research and presentations. Only eight people had a say. McLellan, Cafaro, and Davis were among them. The mid-engine Corvette didn't get a single vote. McLellan looked at the numbers—both cost and performance—and knew that no mid-engine design could compare to a backbone Corvette.

The car they were calling C5 was settled on that day. It took only five more years to make it happen.

Cable TV Strikes Back



LONG INFAMOUS for their cavalier approach to customer service and picture quality, cable TV operators are finally wak-

By Jonathan Takiff ing up and smelling the coffee: Five mil-

lion of their best premium-service customers have been lured away in the past two years by small-dish satellite TV systems flaunting their ultraclean digital reception and as many as 200 TV channels. But now, cable TV has a shot at rounding up some of the deserters and shoring up the remainder of its huge 65 million

customer base, simply by aping the competition. Cable TV's new mantra? "Go Digital!"

"What we're offering is a competitive digital and analog solution," stresses Dan Sutorius, director of digital product management for General Instrument Corp., one of the largest suppliers of set-top cable TV boxes. GI is unveiling its digital delivery system for cable TV, which includes both older analog and new digital MPEG-2 capabilities. MPEG-2 is a compression technology that allows a cable TV operator to send a lot more channels through its existing network.

"A cable operator can keep existing customers with the same level of service," explains Sutorius. "But if a guy wants all the extras—the 150 channels with multiplexed movies, near video-on-demand, sports, infor-

mation, music, electronic program guides, the Internet connection, and all the rest—he gets our new DCT-1000 integrated receiver decoder, complete with all the bells and whistles he needs for these features."

Satellite TV companies have argued that cable TV won't be a worthy rival until America is rewired with fiber-optic cable. Until now, that argument had validity. But cable TV has figured out how to piggyback digital signals onto its existing coaxial wire network. So, let the competition for viewers begin—a war that can only benefit couch potatoes everywhere. Not only does the TV picture improve, but the competition promises to keep the price low.

"All we need is a little unused bandwidth and we can add dozens of digital channels," says GI product manager Carl Vassia. "That's because digital coding is so much more efficient. In the same 6MHz bandwidth that carries a single analog signal, we can multiplex six digital video channels. Want 40 digital audio channels? All you need is 2MHz of bandwidth."

Digital cable solutions are being developed by lots of companies, with names as varied as Scientific Atlanta, Zenith, Thomson, and Pioneer. TCI, the nation's biggest cable TV provider, plans to use another MPEG scheme called Imedia that may allow it to send as many as 16 channels down a single digital bitstream. Imedia isn't expected to be operational until the middle of the year. GI, however, expects to have its digital cable boxes available first.

Bandwidth, of course, is a precious commodity, but if your local cable TV operator has 200MHz to spare (it's often achieved just by upgrading the amplifiers in the system), more than 200 programming services can be made available. And if your cable TV system upgraded to fiber-optic cable, the palette of options would be even broader. Even the analog channels would look better.

Stung by satellite TV systems, cable TV mounts a digital counteroffensive.

PHOTO-ILLUSTRATION BY ERIC YANG

Where Digital Programs Come From

CABLE TV operators do most of their digital program shopping in two places. TCI's Headend-in-the-Sky (HITS) in Littleton, Colorado, delivers 80 MPEG-2 video channels and 40 digital music channels via satellite. The second program supplier, TVN Entertainment Corp. of Burbank, California, offers 40 MPEG-2 video channels. Both services also offer electronic program guides that are downloaded daily. Weighing heavily in the program mix are pay-per-view channels, premium movies, sports packages, and special-interest channels that older analog cable TV systems lack the bandwidth to carry.—J.T.

Inside GI's labs outside Philadelphia, a model cable TV plant replete with 10 run-of-the-mill line amplifiers, signal-weakening taps, and lots of noise-inducing sources cranks up to demonstrate the robustness of GI's digital TV solution. In the older analog mode, white noise from a power drill splatters all-too-familiar dotted lines across the TV screen. Change the connection to digital, and the pictures look perfectly clear and crisp, with resolution and color purity rivaling that seen on satellite TV. When the carrier-to-noise signal ratio was cut to less than half of normal, the analog feed disappeared into a sea of snow, but the digital picture held its own under the same conditions.

Meanwhile, the audio quality promises to thrill. The GI system subscribes to the Dolby Digital AC-3 standard and is similar to that being adopted for DVD and High Definition TV (HDTV). The big difference is that the cable version is strictly stereo for now, so surround-sound won't be part of the equation. Surround-sound is likely to be available as an option on future digital cable boxes.

modem and, for future use, a 40-pin high-speed cable connector. Still, the \$400 price tag is about \$100 more than many cable TV operators say they are willing to pay. GI argues that cable operators will quickly make up the higher cost as viewers order more programs.

Hardware costs will also drop "as we learn which features are important and which are not," says Sutorius. GI plans to manufacture more than one million digital cable boxes this year. Scientific Atlanta, Zenith, and Hewlett-Packard are also licensed to buy GI chipsets and incorporate them into their own compatible boxes. Zenith is also backing another set-top solution developed by Divicom.

But there is another incentive for cable TV operators to make the move to digital. Adding digital channels is much less expensive and space consuming than upgrading their existing analog service.

Digital cable TV also promises much better security against signal theft, the bane of many cable TV operators' existence. The system conforms to the government-sanctioned data encryption standard and uses GI's Digi-Cipher technology for access control and authorization.

"If someone tries to crack open the decrypting chip to read the algorithm, the chip literally self-destructs," says GI product manager Max Brogi. "We've got downloadable electronic options that change the system. And if by some miracle the security is still breached, we've got a slot in the back of the box that lets us alter the system with a plug-in card."

And then there are the extras available through GI's digital hardware. The company's DCT-1000 digital cable box delivers **services** that were once nothing more than pipe dreams. For instance, there's Music Choice, CD-quality audio delivered by Digital Cable Radio that comes with an extensive onscreen display of track information, artist profiles, music news, trivia challenges, and an inter-

Sports fans can shift between or isolate and follow a

With an eye to flexibility and to fulfilling as many scenarios as possible, GI has "overbuilt" its first-generation digital cable box and is claiming only slim margins of profitability on the \$400-per-box price it charges. Inside the box are two megabits of video DRAM, one megabit of DRAM for applications and graphic display, one megabit of ROM for basic operations, and one megabit of SRAM for downloading program guides. There is also a 14.4Kbps

active music-buying service. Tune into the same service on DSS satellite TV, by contrast, and all that's displayed is the genre of music you're hearing. To be fair, future generations of satellite TV will offer similar capabilities.

Another extra is an Internet connection. WorldGate is GI's low-cost Internet solution for the TV. "The beauty and economy of our system is that most of the hard work—grabbing and caching information off the Internet—is

The Digital Cable TV Box at a Glance



How different is a digital cable TV receiver from the one with which so many cable TV subscribers are familiar? From an operational standpoint, there isn't much difference. Worth noting are the "guide" button, which displays a time grid of

program listings and the "info" button, which shows TV listings for the channel you're watching. It's the digital technology inside the box, of course, that makes the picture clearer and the channel capacity greater.—J.T.

managed at the cable head-end," explains World-Gate developer Hal Krisberg. "The set-top box essentially serves as a dumb terminal, just downloading one page at a time and sending back a few keystrokes. That's one reason the response is so fast—it's three seconds to any Web site. It's also why we can handle as many as 3,000 active sessions simultaneously in a single cable node (a system subnetwork) that typically runs to 1,000 to 2,000 homes. And all we use is 6MHz of bandwidth."

Like other Internet solutions for TV, WorldGate can be operated with a remote control and onscreen keyboard, or with an external keyboard; the latter is the best choice, especially if you're planning to do serious e-mail communications. WorldGate resizes Web pages into two large-font options for easy reading at a distance.

WorldGate is special, though, in that you can summon

The appropriate Cadillac Web page is downloaded to the viewer. Advertisers should love it, and hopefully pay for it."

Perhaps most remarkable is the price. WorldGate expects to deliver unlimited Internet access for less than \$5 per month, substantially lower than the \$19.95 per month most Internet providers now charge.

Cable operators also have the option of adding their own extras. Using a set-up called CableSoft, cable companies can create their own community Web services for e-mail, news, stock quotes, and classified advertising.

CableSoft also interfaces with a technology called Wink that delivers Web pages in the TV signal's vertical blanking interval—the black bars at the top and bottom of a video frame. To the viewer, it appears to be a separate channel, but it only uses a tiny bit of bandwidth. Wink flashes an onscreen icon to let the viewer know that interactivity is available on the program. A viewer might then order a recipe from a cooking show, for example.

Down the road, digital cable TV promises even greater interactivity. Perhaps the most intriguing is ACTV, which allows a viewer of a sporting event to act like a director. You can shift between cameras, follow a specific player, call up game statistics or instant replays, or review scoring plays. News hounds, meanwhile, could opt to view reports of special interest or participate in a news quiz. While ACTV has been available on some analog cable systems in Southern California for about a year, "it's really optimized for digital cable because of its heavy bandwidth demand," says GI's Sutorius. "ACTV is

simulcasting on four channels. It kills an analog cable TV system operator to give up all that bandwidth, but in a digital domain with excess capacity, it's no big deal."

And that will be even less of a big deal when GI unveils a second-generation modulating technology that promises to increase capacity by another 40 percent.

Start looking over your shoulder, satellite TV. The cable TV guys have only now begun to fight. ♦

een cameras single player.

a Web site appearing on the screen at the touch of a button. How do they do that? "We pre-cache all the Web sites that are going to be shown on TV that day," explains chief financial officer David Dill. "When the customer hits the 'access address' button, it sends a radio-frequency signal up the cable line, so we know he's watching channel 3 at 7:13 p.m. A computer cross-references that information and determines that a Cadillac commercial is airing at that moment.



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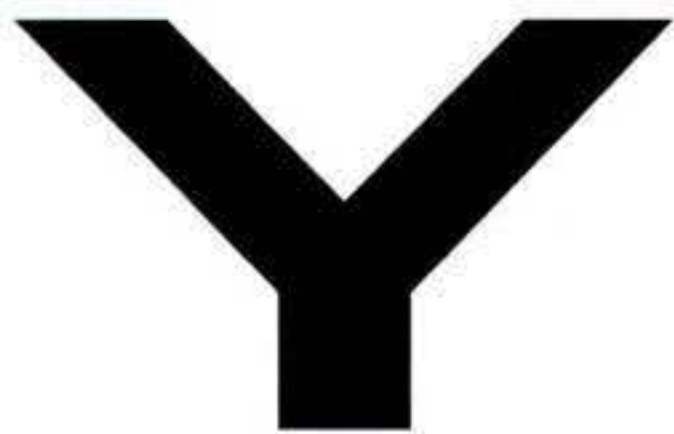
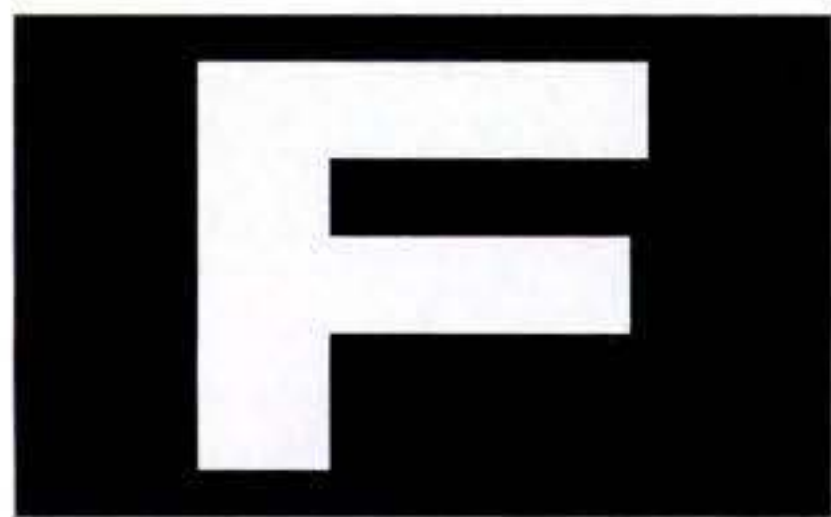
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ASK POPULAR SCIENCE

Why do “hot” foods such as hot sauce or peppers create a burning sensation on the tongue? Why does milk soothe it?

Katherine A. Cobb
kacobb@juno.com

THE ORAL ARSONIST in chili peppers or hot sauce is a compound called capsaicin. It has just the right shape to lock onto nerve endings, or receptors, inside your mouth and on your lips. Once that connection is made, the nerves send signals to the

brain that your brain interprets as pain. Just to make sure you get the message, capsaicin triggers nerves to release another chemical, substance P, which also generates pain signals.

Swishing cold water around your mouth momentarily stops the burning, but since capsaicin is still latched onto the receptors, the pain returns. (Actually, many people consider the burning sensation pleasurable.) Milk contains a protein called casein that knocks capsaicin off the receptors and settles onto them it-

self, says Dr. Robert Henkin, director of the Taste and Smell Clinic in Washington, D.C. Warm milk may be the best fire extinguisher of all, “but when your mouth is on fire, I can’t imagine waiting around for someone to heat up some milk,” says Henkin.

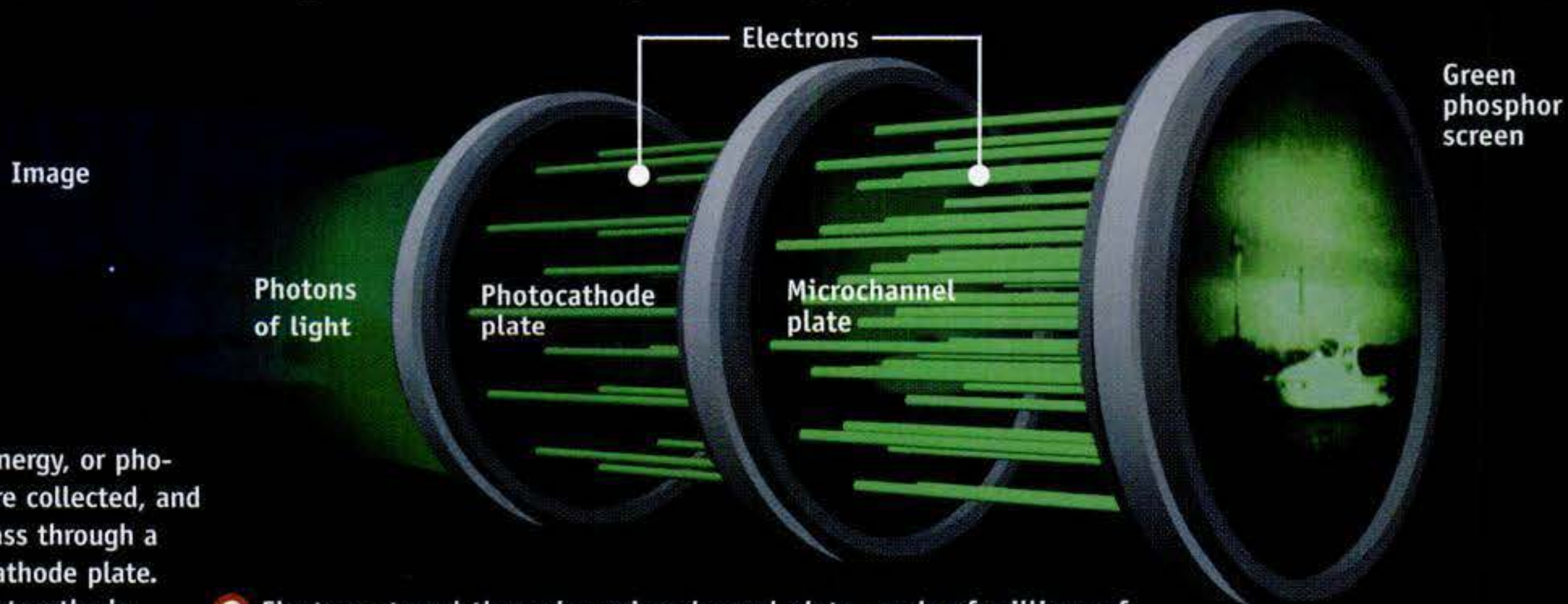
If there isn’t any milk handy, try sugar water or a sweet soda, suggest food science researchers at the University of California, Davis, whose 1990 study, “Temporal effectiveness of mouth-rinsing on capsaicin mouth burn,” was published in the journal *Physiology and Behavior*.

One interesting note: Even

HOW IT WORKS

Night Vision Scope

YOU WANT TO GO FISHING on your boat, but it’s a dark, moonless night. No problem: You bring your night scope. Originally developed for the military, these commercially available systems are shaped like binoculars or monoculars and collect and amplify available visible light. There are other night-vision technologies that are more costly and rely on infrared light to show warm objects. These are used by the military, police, and rescue workers.—*Mariette DiChristina*



1 Light energy, or photons, are collected, and then pass through a photocathode plate. The photocathode works on a principle similar to that used in solar cells: When it is struck by the photons, the plate emits electrical energy, or electrons.

2 Electrons travel through a microchannel plate, made of millions of tiny fiberoptic tubes bundled into a cylinder, sliced into wafer-thin plates, and treated to become electrochemically active. At this plate, the electrons are increased in number, upping electrical energy. This, in turn, amplifies the brightness of the image you see. Each incoming electron strikes others in the plate, freeing them. By the time the original electron exits, it brings some 2,000 more with it.

3 The electrons strike a phosphor-coated screen. The screen then emits visible light. You see the resulting, brighter images.

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Rocky Mountain Radar introduces a device guaranteed to make your car electronically "invisible" to speed traps—if you get a ticket while using the product, the manufacturer will pay your fine!



■ **The Phazer will "jam" both radar and laser guns, preventing police from measuring your speed.**

If your heart doesn't skip a beat when you drive past a speed trap—even if you aren't speeding—don't bother reading this. I can't tell you how many times that has happened to me. Driving down the interstate with my cruise control set at eight miles over the limit, I catch a glimpse of a police car parked on the side of the road. My heart skips a beat and for some reason I look at my speedometer. After I've passed the trap, my eyes stay glued to my rear view mirror, praying the officer will pass me up for a "bigger fish."

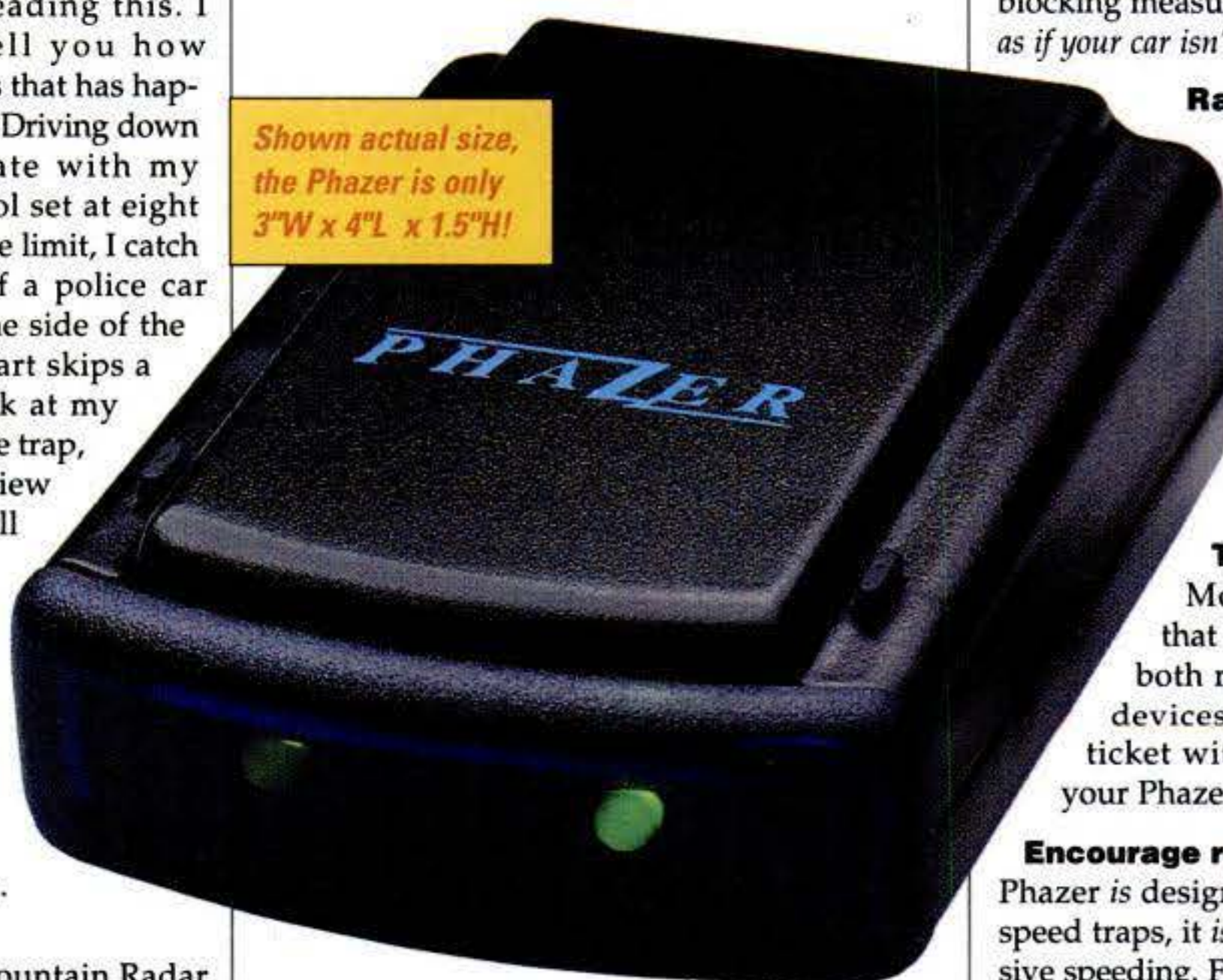
It seems that as speed-detection technology has gotten more and more advanced, speeding tickets have become virtually unavoidable. And although devices exist that enable motorists to detect these speed traps, they are outlawed in many states... including mine.

The solution. Today, Rocky Mountain Radar offers drivers like me a perfect solution—the Phazer. Combining a passive radar scrambler with an active laser scrambler, the Phazer makes your automobile electronically "invisible" to police speed-detecting equipment.

The radar component works by mixing an X, K or Ka radar signal with an FM "chirp" and bouncing it back at the squad car by way of a

waveguide antenna, effectively confusing the computer inside the radar gun. The laser component transmits an infrared beam that has the same effect on laser Lidar units.

Shown actual size, the Phazer is only 3"W x 4"L x 1.5"H!



Perfectly legal.

Some radar devices have been outlawed because they *transmit* scrambling radar beams back to the waiting law enforcement vehicle. The Phazer, however, *reflects* a portion of the signal plus an added FM signal back to the police car. This, in effect, gives the waiting radar unit an electronic "lobotomy."

Best of all, unless you are a resident of Minnesota, Oklahoma or Washington, D.C., using the Phazer is completely within your legal rights.

HOW TO MAKE YOUR CAR DISAPPEAR

Radar and laser scramblers are devices that foil speed traps by making vehicles electronically "invisible" to police radar. Radar scramblers mix a portion of the radar signal with background clutter and reflect it back to the squad car. This technique, pioneered by Rocky Mountain Radar, creates an unreadable signal that confuses the computer inside the radar gun.

The laser scrambler in the Phazer works in a similar manner. It transmits a special infrared beam with information designed to scramble the laser signal. The result? Readouts on police radar and laser guns remain blank. As far as the police officer is concerned, your vehicle is not even on the road.

■ **The Phazer makes your car invisible to police radar and lasers or the manufacturer will pay your speeding ticket!**



How it scrambles radar.

Police radar takes five to 10 measurements of a vehicle's speed in about one second. The Phazer sends one signal that tells the radar the car is going 15 m.p.h. and another signal that the car is going 312 m.p.h. Because police radar can't verify the speed, it displays no speed at all. To the radar gun, your car isn't even on the road.

Works with laser, too! The Phazer also protects your vehicle from Lidar guns that use the change in distance over time to detect a vehicle's speed. The Phazer uses light-emitting diodes (LEDs) to fire invisible infrared pulses through the windshield. Laser guns interpret those pulses as a false indication of the car's distance, blocking measurement of your speed. Again, it's as if your car isn't even on the road.

Range up to three miles.

The Phazer begins to scramble both radar and laser signals as far as three miles away from the speed trap. Its range of effectiveness extends to almost 100 feet away from the police car, at which point you should be able to make visual contact and reduce your speed accordingly.

Ticket rebate program. Rocky Mountain Radar is so confident that the Phazer will protect you from both radar and laser speed-detection devices that if you do get a speeding ticket within the first year while using your Phazer, they will pay your fine!

Encourage responsible driving. While the Phazer is designed to help you (and me) avoid speed traps, it is *not* intended to condone excessive speeding. For that reason, the manufacturer will only pay tickets where the speed limit was not exceeded by more than 30%, or 15 miles per hour, whichever is less.

Risk-free. Thanks to the ticket rebate program, speed traps don't make my heart skip a beat anymore.

Try it. Your car will be invisible to police radar and laser, or the manufacturer will pay your fine! It's backed by our risk-free trial and three-year manufacturer's warranty. If you're not satisfied, return it within 90 days for a full "No Questions Asked" refund.

The Phazer \$199 \$14 S&H

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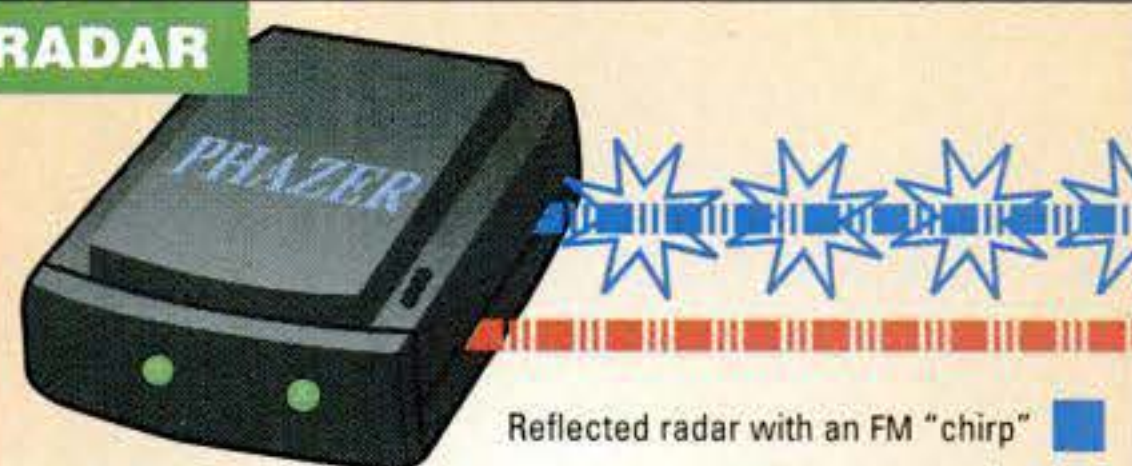
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■ **The Phazer is a completely legal way to protect yourself from speed traps (except in OK, MN and Washington DC).**

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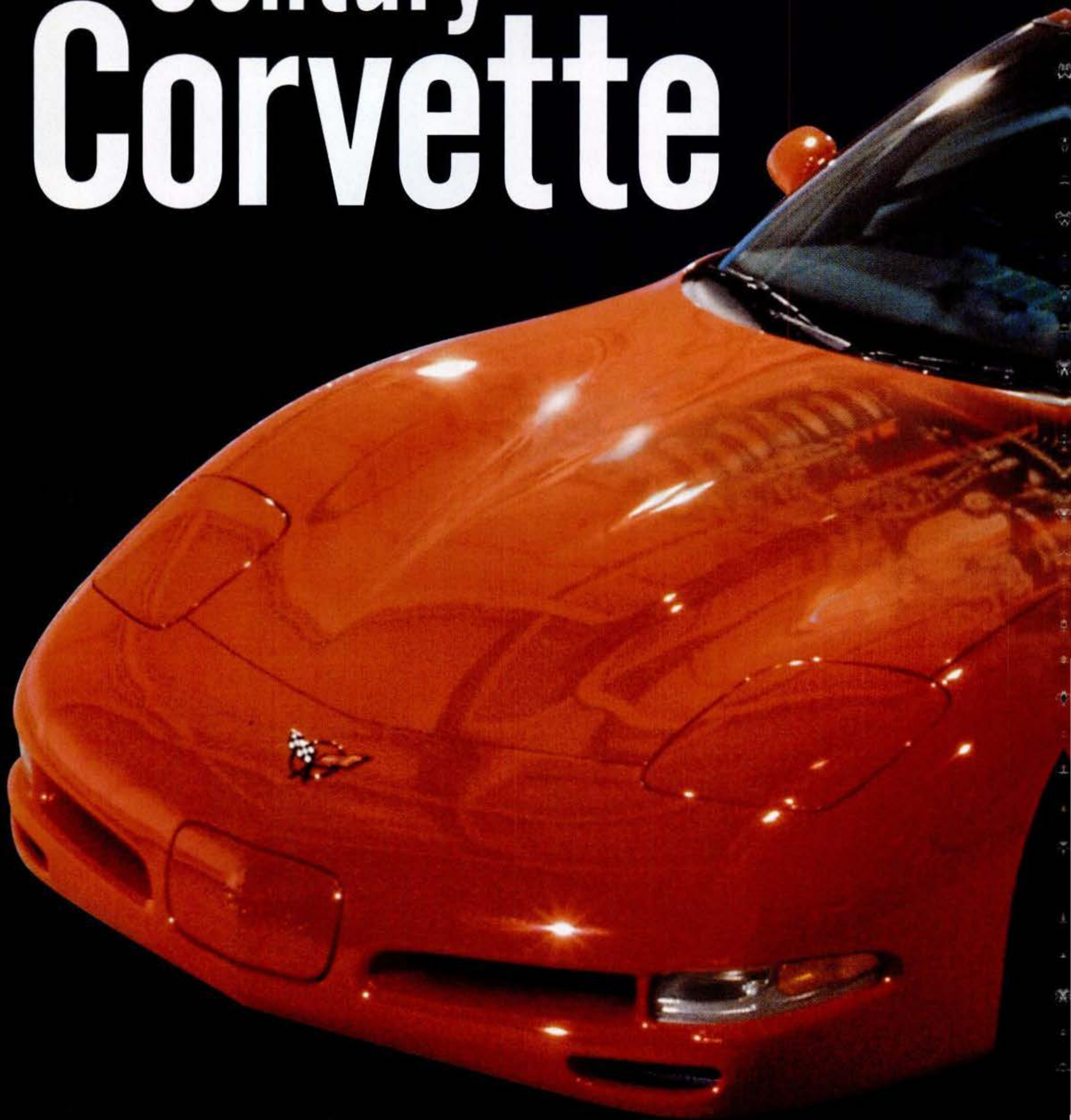


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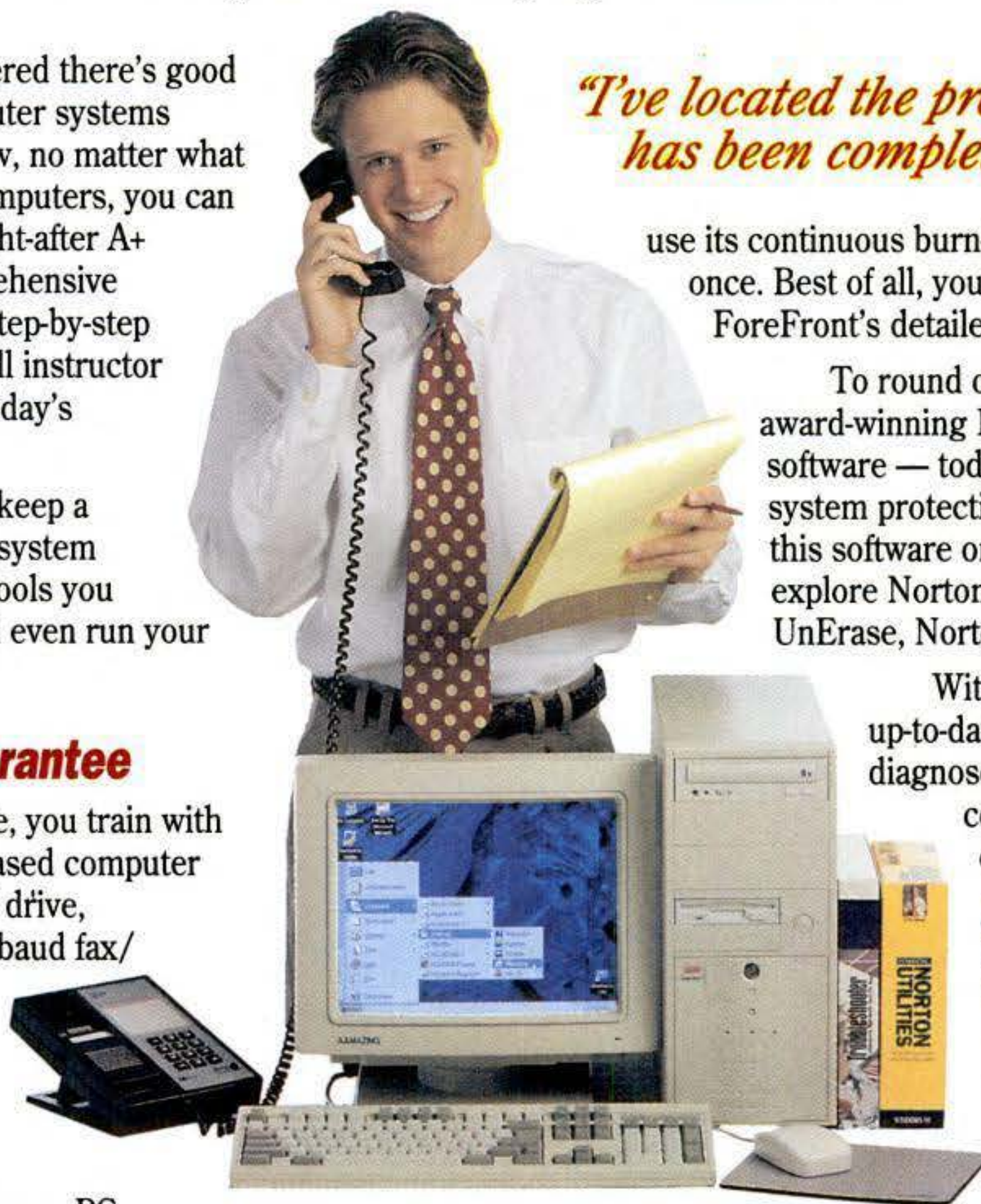
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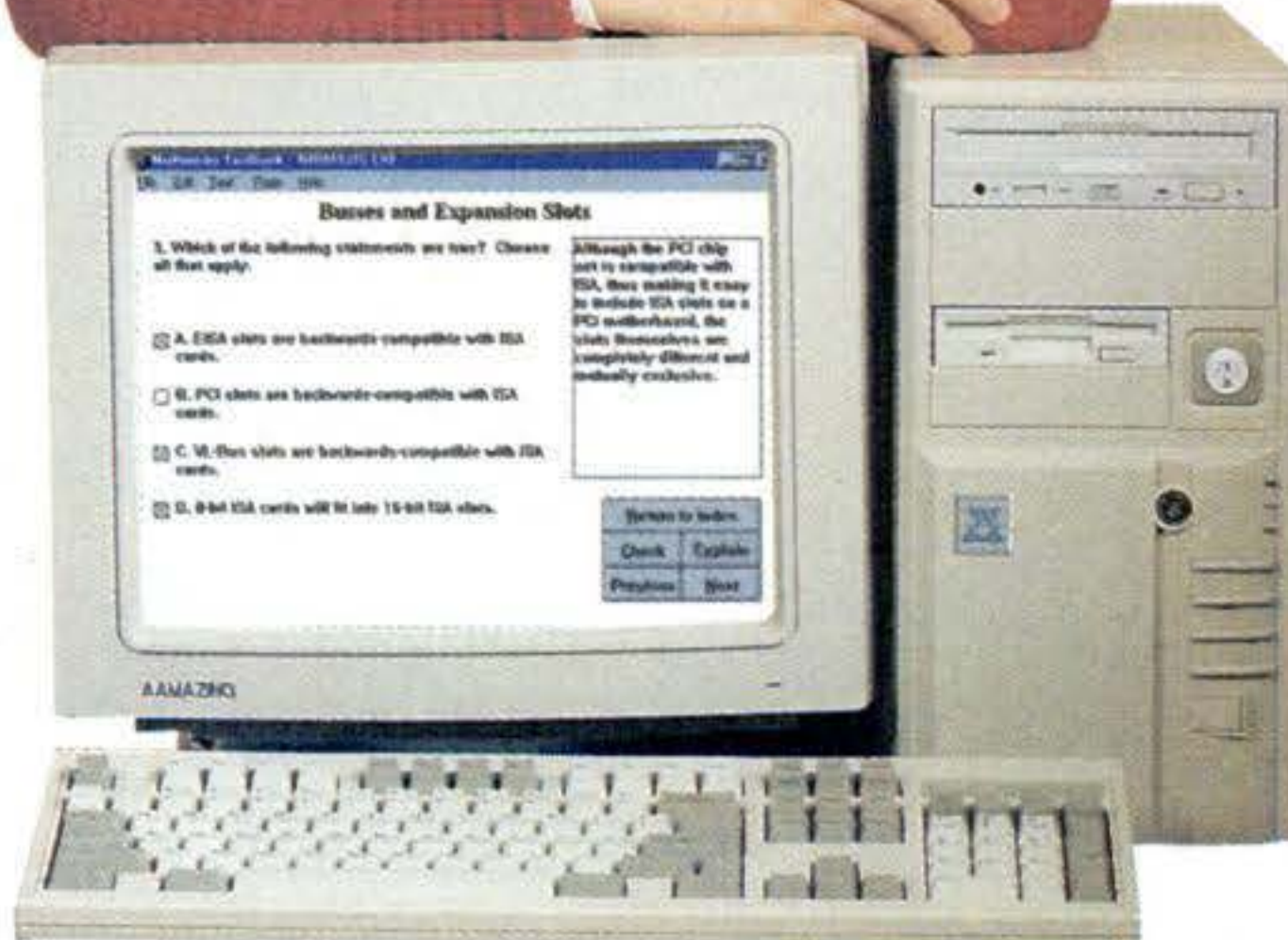
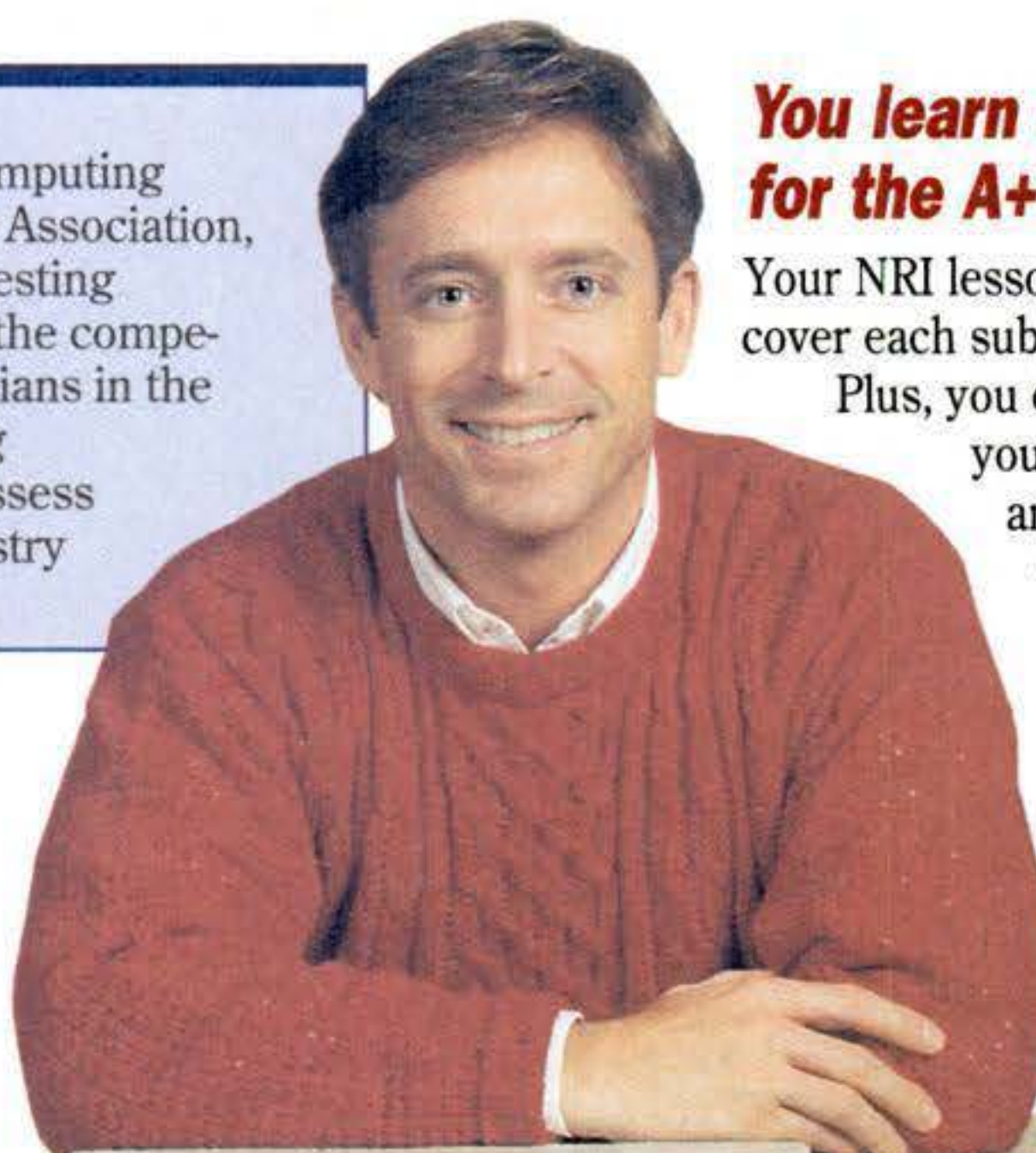
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though capsaicin causes your mouth to burn, it is now being used as a pain reliever for a variety of ailments.

If light has no mass, how can black holes trap it?

Jason Wallace
wallace.164@osu.edu

ACTUALLY, IT doesn't matter what mass light has—although you're right, it doesn't have any. It's still going to be trapped once it's captured by a black hole.

"What black holes or strong gravity do is bend or warp or twist the very fabric of space and time itself," explains Andrew Fraknoi, chairman of the astronomy department at Foothill College in Los Altos Hills, California, and the Astronomical Society of the Pacific. "Any innocent victim [such as light] that comes into the neighborhood still has to travel through space. If space itself is warped or bent or twisted, then beings of light, spacecraft, or presidential candidates will find their paths warped, too."

The effect is strongest in black holes, which are objects so utterly collapsed, so unimaginably dense that mere teaspoonfuls could weigh many tons. "In a black hole, straight lines [of travel] become circles," adds Fraknoi, "so all paths out become paths in." In effect, light is trapped in a circular path inside the black hole.

Is it possible to use the spinning of the wheels to produce electricity that can be stored and used in a car? If so, why hasn't it been done?

Castillo Vargas Gerardo
9607776@itcr-li.li.itcr.ac.cr

THE ANSWER to the first part of your question is yes, it's possible to use wheels to store energy. There are two kinds of wheels you may be referring to: flywheels and the wheels on the car itself. We'll discuss and explain both.

First, the flywheel. You can think of this as a mechanical battery. But instead of using chemicals to store energy, as do lead-acid batteries, a flywheel uses motion—it spins. A flick of energy current starts the motion, and then the flywheel ro-

tates on near-frictionless bearings in a vacuum housing. The faster the flywheel spins, the more energy it stores. Many flywheels would be needed to provide enough energy to power a car.

A car's wheels can also store

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- Wednesday, January 22, 8:30 to 9 p.m. & 11:30 to 12 a.m. EST

DEMON ON WHEELS

SEE CRAIG BREEDLOVE in action. The several-time land-speed-record holder wants to regain the record—with his sights ultimately set on breaking the sound barrier on land. His vehicle, named The Spirit of America, uses a J-79 GE jet engine from a Navy F4 fighter aircraft. Using unleaded gas, it develops 22,650 pounds of thrust—equal to 45,000 horsepower.



HOT ZONE

LEARN HOW the Centers for Disease Control in Atlanta contains and studies deadly "Hot Zone" viruses, like the insidious Ebola Zaire, which can kill unprotected humans at an astonishing rate.

FYI: WHAT IS STEALTH?

POPULAR SCIENCE contributing editor Stuart F. Brown explains stealth technology and forecasts future innovations.

- Wednesday, Jan. 29, 8:30 to 9 p.m. & 11:30 to 12 a.m. EST
- Sunday, February 2, 6 to 6:30 p.m.

THE TOP F/X

HOW DOES Hollywood make it all look so real? Find out at Digital Domain, the special effects house responsible for films such as *Terminator*, *Terminator 2*, *Aliens*, and *Apollo 13*. *Terminator 2*, for instance, was the first major production to be 100 percent digitally processed—every frame was computer-manipulated for special effect.

HOME, FUTURE HOME

A \$6 MILLION 3,500-square-foot showcase in Pittsfield, Massachusetts, is demonstrating what home living might be like in the future. Built in 1989 by GE Plastics, the Living Environments Concept Home is a constantly upgraded testbed for the latest technologies. The talking command center accepts verbal instructions to fill your bathtub, water the lawn, and print a photograph of visitors who come to your front door while you're away.

- Wed., Feb. 5, 8:30 to 9 p.m. & 11:30 to 12 a.m. EST
- Sunday, February 9, 6 to 6:30 p.m.



GOING BATTY

THEIR LOOKS notwithstanding, some bats have downright lovable habits. For one example, the 1.5 million Mexican free-tail

bats who live at the Congress Avenue Bridge in Austin, Texas, eat 250 tons of insect pests; for another, bat droppings support whole ecosystems. Texans are retrofitting bridges to better shelter endangered bats. Brian Keeley, wildlife biologist, guides the tour of bridges and caves.

ATTACK HELICOPTER

THE LONG BOW Apache Helicopter is the U.S. military's latest attack chopper. Six prototypes have been built to date by McDonnell Douglas, with more on the way before the decade is



out. The helicopter contains radar-targeting technology that lets it pinpoint and shoot 16 separate targets in a minute. A high-speed modem transmits digital information to the battlefield.

FYI: HOW DOES ACUPUNCTURE WORK?

WITH THIS 4,000-year-old treatment system from China, needles are inserted into any of 1,000 acupuncture points for healing. Recently, acupuncture received FDA recognition as a valid form of medicine.

- Wed., Feb. 12, 8:30 to 9 p.m. & 11:30 to 12 a.m. EST
- Sunday, February 16, 6 to 6:30 p.m.

TIME MASTERS

OXFORD SCIENTIFIC Films of England is renowned for slow-motion and time-lapse photography, with credits in many films. One achievement: capturing a racing bullet, which appears to be at a standstill in midair. The shot was taken with a Phodac Drum Camera firing away at 250,000 frames per second. Take behind-the-scenes looks at photographing a karate chop of a board, and a tablecloth being pulled from underneath a setting.

ON WOUNDED KNEE

AS A REPLACEMENT for ailing joints, a relatively new treatment—real cartilage—is preferable to troublesome mechanical joints. Genzyme extracts healthy tissue, grows it in a lab, and then inserts it into a damaged joint, such as a knee. The treatment speeds healing, and the new joint lasts longer than a mechanical replacement.

After Years Of Making Love The Same Old Way, Here's An Exciting New Beginning.

Even in the best relationships, lovemaking can lose its excitement all too soon. That's why we've created The Better Sex Videotapes, hosted by nationally famous sex educator Dr. Judy Seifer.

The Better Sex Videotapes show how to put fun back into lovemaking. They teach us not to be satisfied with "going through the motions", but to aim for heights of ecstasy most people only dream about.

Dr. Seifer introduces three typical couples who show how to overcome inhibitions and make sex fun again. They begin with the basics—intimacy, gentleness, and good communications.

This series is controversial—so much so that it has been featured on HBO. Yet tens of thousands have ordered Better Sex Videotapes. They are used in universities, and recommended by family doctors, gynecologists, psychologists, and sex therapists.

Why is it controversial? Simply because it is explicit. Each and every technique is not just talked about but demonstrated. Each lesson is shown from start to finish, in detail—preferably to be watched and discussed by both partners together.

Who orders Better Sex Videotapes? Married people seeking to restore the sense of discovery they had when they first met. Sexually active young men and women who seek only to find new ways to satisfy the ones they love. Couples in their 40s, 50s, and 60s desiring to rekindle the passion of their younger days—often as a specially meaningful gift.

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energy. In this case, the flywheels would be used to provide intermediate energy storage in cars that have hybrid drives.

Hybrid drives combine a fuel, such as gasoline, with other technologies, such as flywheels. In a hybrid drivetrain, the flywheel could capture spinning energy from the car's wheels as the brakes are applied. This energy would then be available to assist with acceleration.

Several car manufacturers have experimented with flywheels for energy storage, but the technology hasn't gone beyond the test phase. One recent setback for the development of this technology is that Chrysler killed funding for its Patriot hybrid-drive car project. Unlike lead-acid or other conventional batteries, flywheels have the potential to recharge more rapidly, last 10

times longer, use no hazardous chemicals, and tolerate nearly any outdoor temperature. But the downside is that flywheels—which have been used successfully in space and for large commercial applications—are very expensive compared with conventional technologies. Not only that, but their rapid rotation—they can spin at thousands of rpm—raises safety and engineering issues in smallish moving vehicles such as cars. So, applying the technologies to cars is possible, but remains in our future for now.

What really happens when your muscles fall asleep?

Russ Brown
via e-mail

ACTUALLY, NOTHING is happening to your muscles, it's your nerves that

are giving you that creepy feeling. When your arm falls asleep, it's your ulnar nerve. When your leg falls asleep, it's your interior tibial nerve. Both are named for a nearby bone.

Here is a typical scenario: Say you're trapped in a middle seat in coach on a crowded, six-hour flight. You feel like a sardine, and you don't wiggle for fear of disturbing your weightlifting neighbors. Suddenly, your leg goes numb. You stumble into the aisle, and in a few minutes, the numbness lifts, only to be replaced by a stinging, pins-and-needles feeling.

What happened? Your unrelieved seating position put pressure on the interior tibial nerve, squeezing it. That reduced blood supply to the nerve and it became ischemic, or starved for blood. And that reduced the ability of the nerve to conduct the signals that make muscles move. The result—numbness.

But when you got up, pressure on the nerve was released and normal blood flow resumed. The nerve quickly became active, resulting in the familiar tingling sensation.

The same process is involved when your arm "falls asleep," as it might from resting for long periods on the arm of a chair.

If a document was signed at exactly midnight, what would be the correct date to apply to the document—the day that just ended or the day that just began?

Mel Sher
Marblehead, Mass.

LEGALLY, THE choice is up to you, since midnight straddles both days. According to *Words and Phrases: 1658 to Date*, a comprehensive encyclopedia of judicially defined terms, many courts have ruled that the day begins at midnight and ends the following midnight. According to Coordinated Universal Time, the successor to Greenwich Mean Time, a day begins at 0000—zero

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Dear Friend,

I made \$9,800 in 24 hours. You may do better!

My name is John Wright. Not too long ago I was flat broke. I was \$31,000 in debt. The bank repossessed my car because I couldn't keep up with the payments. And one day the landlord gave me an eviction notice because I hadn't paid the rent for three months. So we had to move out. My family and I stayed at my cousin's place for the rest of that month before I could manage to get another apartment. That was very embarrassing.

Things have changed now. I own four homes in Southern California. The one I'm living in now in Bel Air is worth more than one million dollars. I own several cars, among them a Rolls Royce and a Mercedes Benz. Right now, I have a million dollar line of credit with the banks and have certificates of deposit at \$100,000 each in my bank in Beverly Hills.

Best of all, I have time to have fun. To be me. To do what I want. I work about 4 hours a day, the rest of the day, I do things that please me. Some days I go swimming and sailing—shopping. Other days, I play racquetball or tennis. Sometimes, frankly, I just lie out under the sun with a good book. I love to take long vacations. I just got back from a two week vacation from—Maui, Hawaii.

I'm not really trying to impress you with my wealth. All I'm trying to do here is to prove to you that if it wasn't because of that money secret I was lucky enough to find that day, I still would have been poor or maybe even bankrupt. It was only through this amazing money secret that I could pull myself out of debt and become wealthy. Who knows what would have happened to my family and me.

Knowing about this secret changed my life completely. It brought me wealth, happiness, and most important of all—peace of mind. This secret will change your life, too! It will give you everything you need and will solve all your money problems. Of course you don't have to take my word for it. You can try it for yourself. To see that you try this secret, I'm willing to give you \$20.00 in cash. (I'm giving my address at the bottom of this page.) I figure, if I spend \$20.00, I get your attention. And you will prove it to yourself this amazing money secret will work for you, too!

Why, you may ask, am I willing to share this secret with you? To make money? Hardly. First, I already have all the money and possessions I'll ever need. Second, my secret does not involve any sort of competition whatsoever. Third, nothing is more satisfying to me than sharing my secret only with those who realize a golden opportunity and get on it quickly.

This secret is incredibly simple. Anyone can use it. You can get started with practically no money at all and the risk is almost zero. You don't need special training or even a high school education. It doesn't matter how young or old you are and it will work for you at home or even while you are on vacation.

Let me tell you more about this fascinating money making secret:

With this secret the money can roll in fast. In some cases you may be able to cash in literally overnight. If you can follow simple instructions you can get started in a single afternoon and it is possible to have spendable money in your hands the very next morning. In fact, this just might be the fastest legal way to make money that has ever been invented!

This is a very safe way to get extra cash. It is practically risk free. It is not a dangerous gamble. Everything you do has already been tested and you can get started for less money than most people spend for a night on the town.

One of the nicest things about this whole idea is that you can do it at home in your spare time. You don't need equipment or an office. It doesn't matter where you live either. You can use this secret to make money if you live in a big city or on a farm or anywhere in between. A husband and wife team from New York used my secret, worked at home in their spare time, and made \$45,000 in one year.

This secret is simple. It would be hard to make a mistake if you tried. You don't need a college degree or even a high school education. All you need is a little common sense and the ability to follow simple, easy, step-by-step instructions. I personally know a man from New England who used this secret and made \$2 million in just 3 years.

You can use this secret to make money no matter how

Here's what newspapers and magazines are saying about this incredible secret:

The Washington Times:

The Royal Road to Riches is paved with golden tips.

National Examiner:

John Wright has an excellent guide for achieving wealth in your spare time.

Income Opportunities:

The Royal Road to Riches is an invaluable guide for finding success in your own back yard.

News Tribune:

Wright's material is a MUST for anyone who contemplates making it as an independent entrepreneur.

Success:

John Wright believes in success, pure and simple.

Money Making Opportunities:

John Wright has a rare gift for helping people with no experience make lots of money. He's made many people wealthy.

California Political Week:

...The politics of high finance made easy.

The Toluca:

You'll love...*The Royal Road to Riches*. It's filled with valuable information...only wish I'd known about it years ago!

Hollywood Citizen News:

He does more than give general ideas. He gives people a detailed A to Z plan to make big money.

The Desert Sun:

Wright's *Royal Road to Riches* lives up to its title in offering an uncomplicated path to financial success.

involved and everything is so easy it can be done whether you're a teenager or 90 years old. I know one woman who is over 65 and is making all the money she needs with this secret.

When you use this secret to make money you never have to try to convince anybody of anything. This has nothing to do with door-to-door selling, telephone solicitation, real estate or anything else that involves personal contact.

Everything about this idea is perfectly legal and honest. You will be proud of what you are doing and you will be providing a very valuable service.

It will only take you two hours to learn how to use this secret. After that everything is almost automatic. After you get started you can probably do everything that is necessary in three hours per week.

PROOF

I know you are skeptical. That simply shows your good business sense. Well, here is proof from people who have put this amazing secret into use and have gotten all the money they ever desired. Their initials have been used in order to protect their privacy, but I have full information and the actual proof of their success in my files.

'More Money Than I Ever Dreamed'

"All I can say—your plan is great! In just 8 weeks I took in over \$100,000. More money than I ever dreamed of making. At this rate, I honestly believe, I can make over a million dollars per year.

A. F., Providence, RI

'\$9,800 In 24 Hours'

"I didn't believe it when you said the secret could produce money the next morning. Boy, was I wrong, and you were right! I purchased your *Royal Road to Riches*. On the basis of your advice, \$9,800 poured in, in less than 24 hours! John, your secret is incredible!"

J. K., Laguna Hills, CA

'Made \$15,000 In 2 Months At 22'

"I was able to earn over \$15,000 with your plan—in just the past two months. As a 22 year old girl, I never thought that I'd ever be able to make as much money as fast as I've been able to do. I really do wish to thank you, with all of my heart."

Ms. E. L., Los Angeles, CA

'Made \$126,000 In 3 Months'

"For years, I passed up all the plans that promised to

h. Probah I am luc I did—but I am even

more lucky that I took the time to send for your material. It changed my whole life. Thanks to you, I made \$126,000 in 3 months."

S. W., Plainfield, IN

'Made \$203,000 In 8 Months'

"I never believed those success stories...never believed I would be one of them...using your techniques, in just 8 months, I made over \$203,000...made over \$20,000 more in the last 22 days! Not just well prepared but simple, easy, fast...John, thank you for your *Royal Road to Riches*!"

C. M., Los Angeles, CA

'\$500,000 In Six Months'

"I'm amazed at my success! By using your secret I made \$500,000 in six months. That's more than twenty times what I've made in any single year before! I've never made so much money in such short time with minimum effort. My whole life I was waiting for this amazing miracle! Thank you, John Wright."

R. S., Mclean, VA

As you can tell by now I have come across something pretty good. I believe I have discovered the sweetest little money-making secret you could ever imagine. Remember—I guarantee it.

Most of the time, it takes big money to make money. This is an exception. With this secret you can start in your spare time with almost nothing. But of course you don't have to start small or stay small. You can go as fast and as far as you wish. The size of your profits is totally up to you. I can't guarantee how much you will make with this secret but I can tell you this—so far this amazing money producing secret makes the profits from most other ideas look like peanuts!

Now at last, I've completely explained this remarkable secret in a special money making plan. I call it "The Royal Road to Riches". Some call it a miracle. You'll probably call it "The Secret of Riches". You will learn everything you need to know step-by-step. So you too can put this amazing money making secret to work for you and make all the money you need.

To prove this secret will solve all your money problems, don't send me any money, instead postdate your check for a month and a half from today. I guarantee not to deposit it for 45 days. I won't cash your check for 45 days before I know for sure that you are completely satisfied with my material.

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There is no way you can lose. You either solve all your money problems with this secret (in just 30 days) or you get your money back plus \$20.00 in cash FREE!

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hours, zero minutes—and ends at 2400, but either of these can be used to designate midnight, says William Klepczynski, who recently retired as the nation's timekeeper as chief of the U.S. Naval Observatory's Time Services Department. To avoid confusion, he suggests a few different options: either date the document as midnight October 21/22, or as 2400 October 21 or 0000 October 22.

The U.S. Naval Observatory, by the way, boasts the most accurate clocks in the country. Its Web page has download links to software you can use to set your computer's clock. Another page tells you when the sun and moon rise and set. You can also read a history of the USNO's involvement in timekeeping, a discussion of the Global Positioning System, and a report on the current status of all the satellites supporting that system. There are even instructions on how to build a sundial. The address: <http://tycho.usno.navy.mil>

Why do stars twinkle?

Tim Wardell

gwardell@computan.on.ca

THE STARS (and planets, for that matter) don't really twinkle. It just seems that way to Earth-bound folks peering through miles of atmosphere at the heavens. Through short distances, air appears clear. But airborne particles and moisture build up to cause the twinkling effect over longer distances.

Sony's MiniDisc seemed like the best idea since the invention of the cassette tape. Why hasn't it become more successful?

jvallido@brml0.med.navy.mil

THE ANSWER may have more to do with market conditions than technical issues. The MiniDisc format, which several companies still support, would seem to be a natural progression from the full-size com-

pact disc. The 2.5-inch MiniDisc is only one-quarter the size of a CD, so MiniDisc players can be very small and portable. MiniDisc offers the same kind of superb digital sound and instant access that CDs do, plus one key feature that CDs don't have: recordability. Sony claims you can record and re-record more than a million times with no loss of sound quality.

So why hasn't MiniDisc caught on? It may simply be a case of too much too soon. Many people who invested in new CD players and compact discs in the late 1980s or 1990s are not ready to switch formats for their home stereos. And many of them have already copied their favorite CDs onto cassette tapes for use in portable stereos, or have purchased boom boxes or Walkman-style stereos that can play standard CDs. Also, the appeal of recording onto MiniDiscs has been dampened by the price of the recordable media, which until recently cost \$13 to \$17 apiece—as much or more than a new CD. That's changing, however. Sony recently dropped the list price of its 74-minute and 60-minute blank discs to \$10 and \$8.50, respectively, and a three-pack of 74-minute discs can be purchased for \$22.

MiniDisc has not gone away. A number of MiniDisc bookshelf-style and portable stereos are being sold. Two of the latest and most innovative are Sony's Qbric and PMC-M2 models, which have both standard CD and MiniDisc players. ♦

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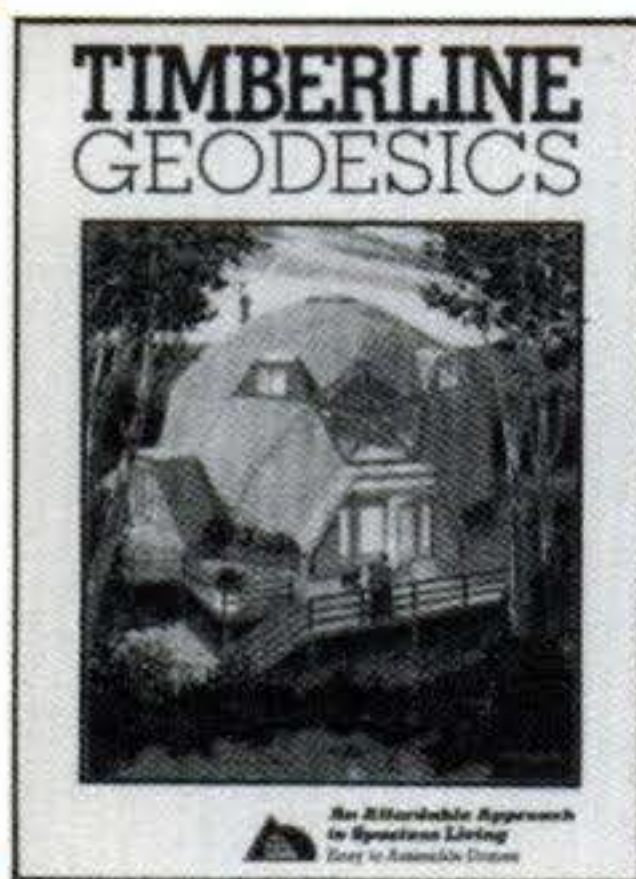
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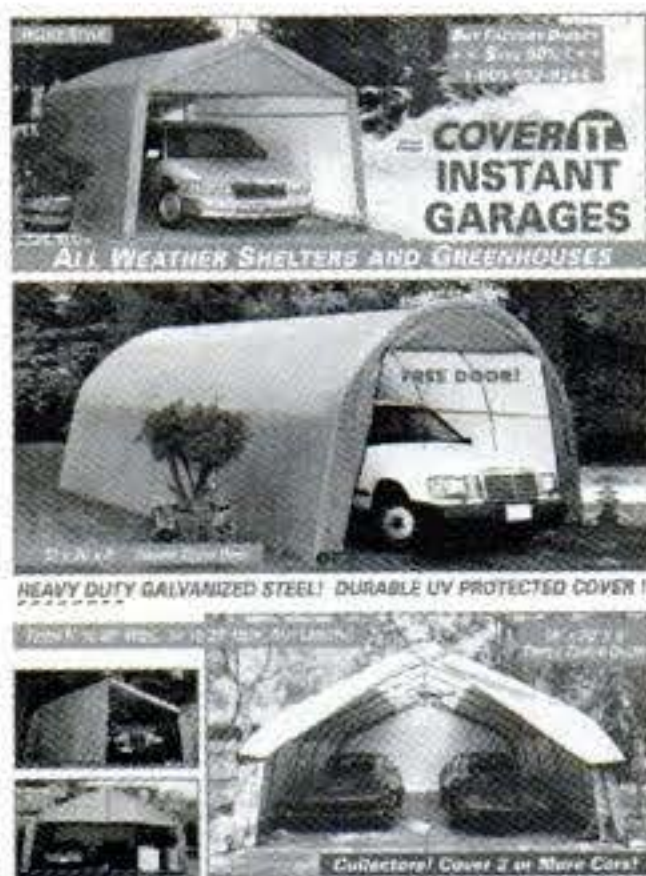


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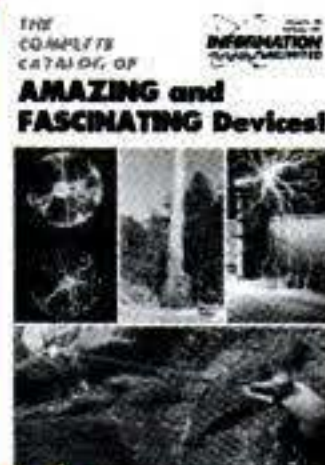
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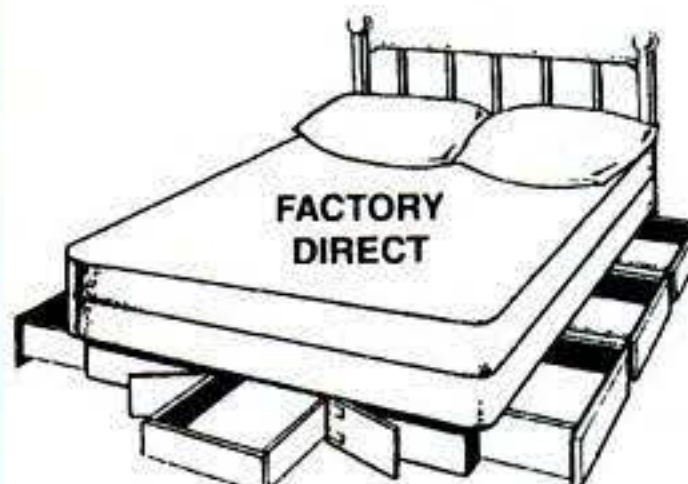
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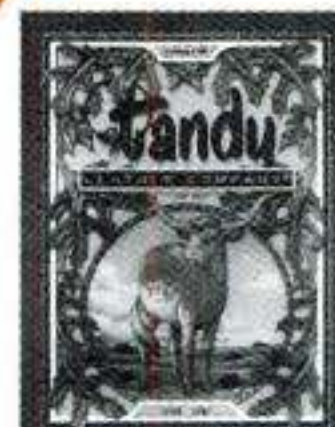
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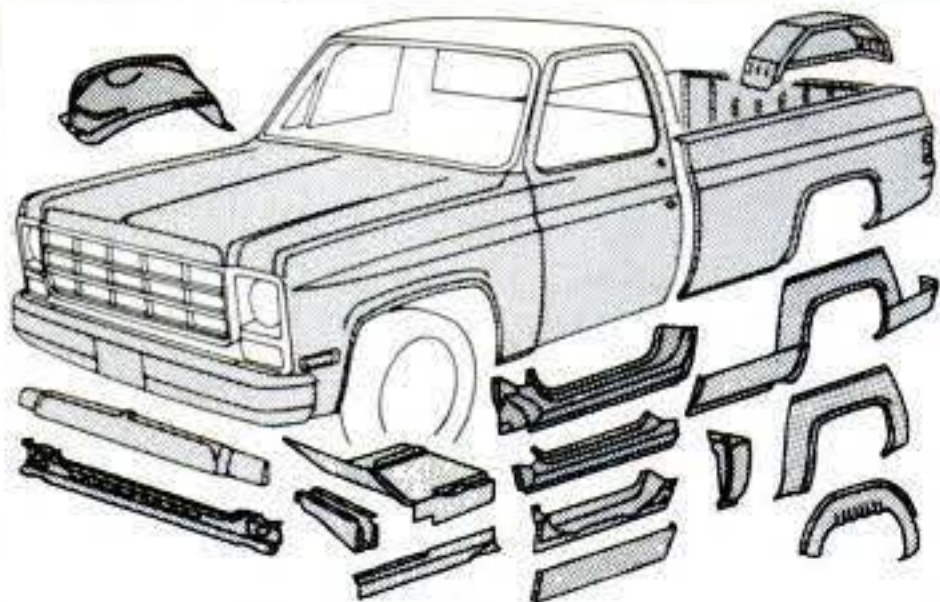
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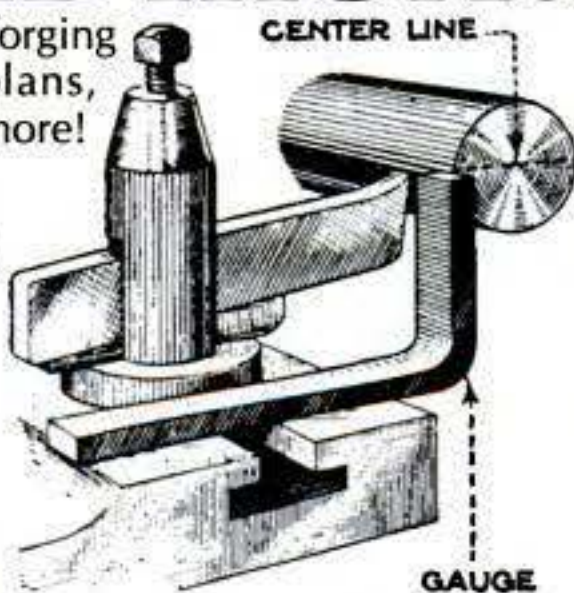
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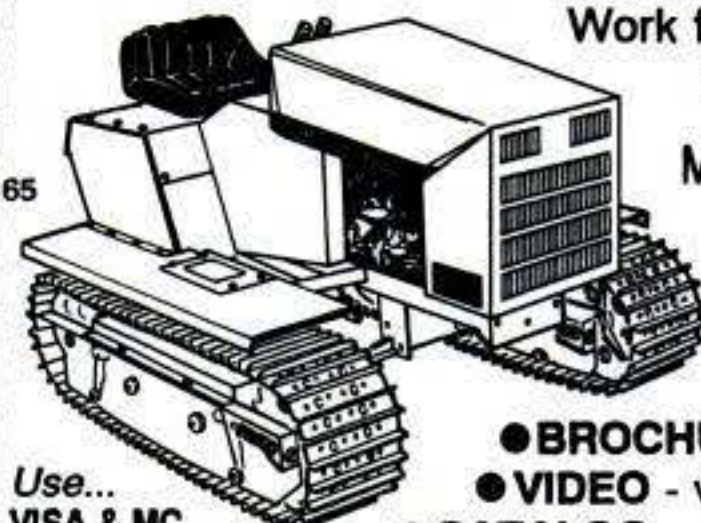


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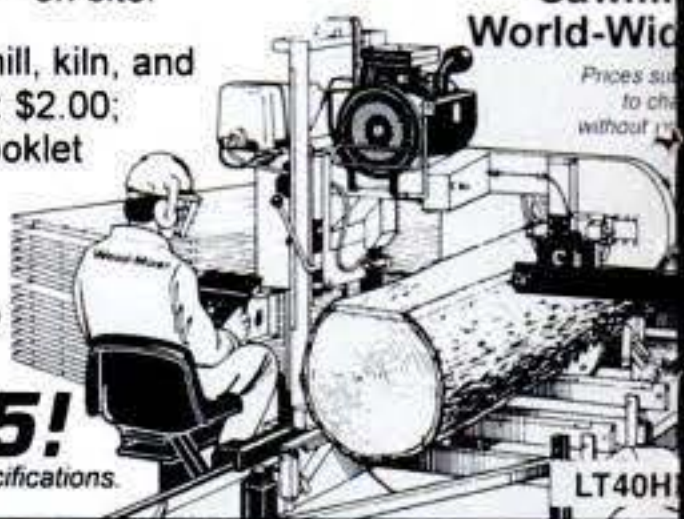
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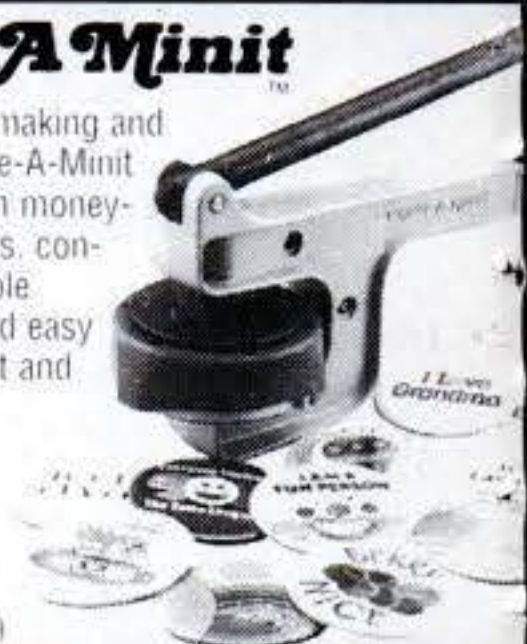
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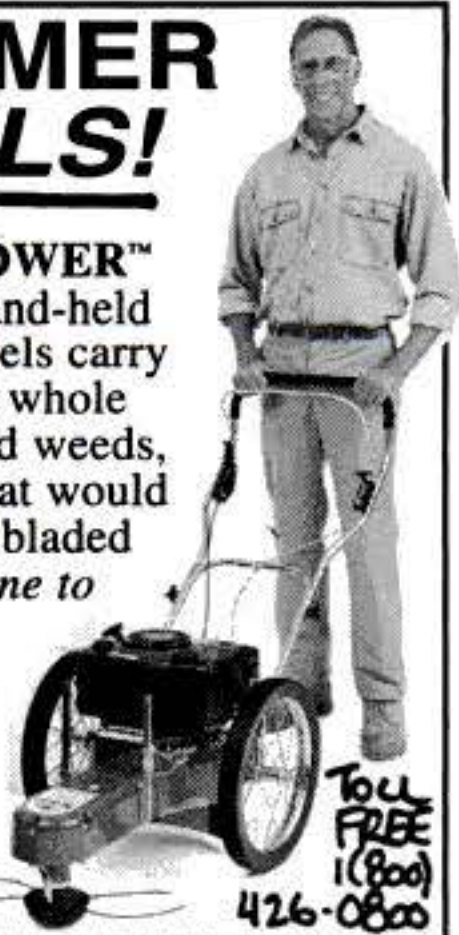
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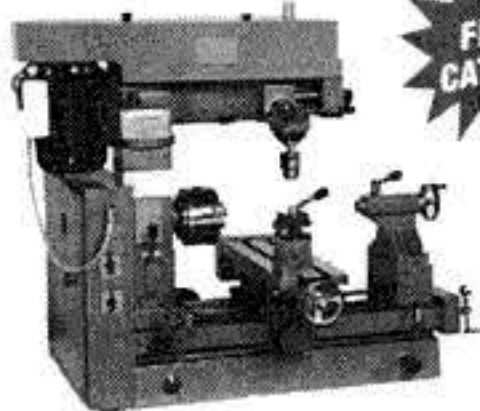
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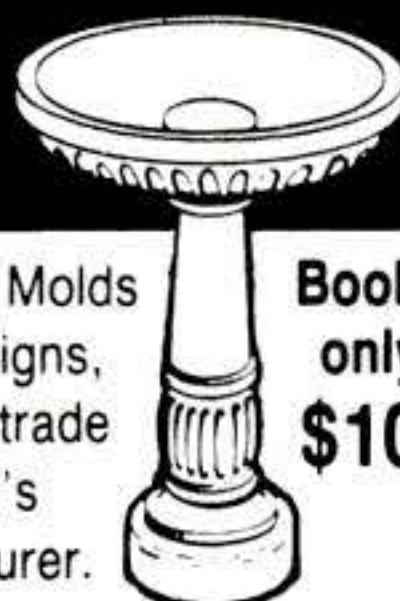
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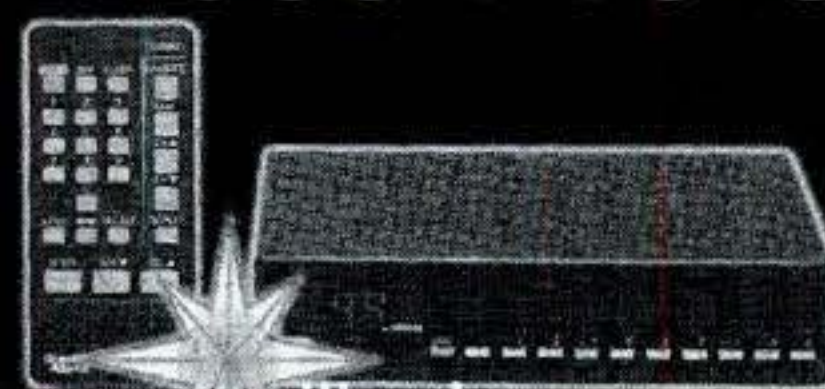
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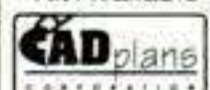
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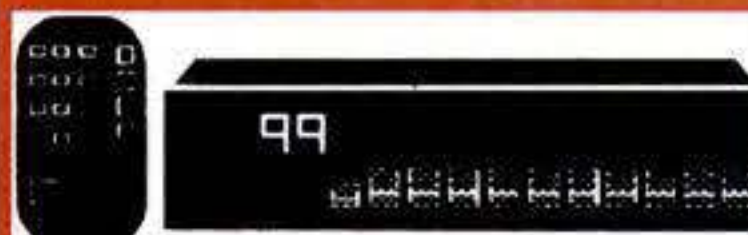
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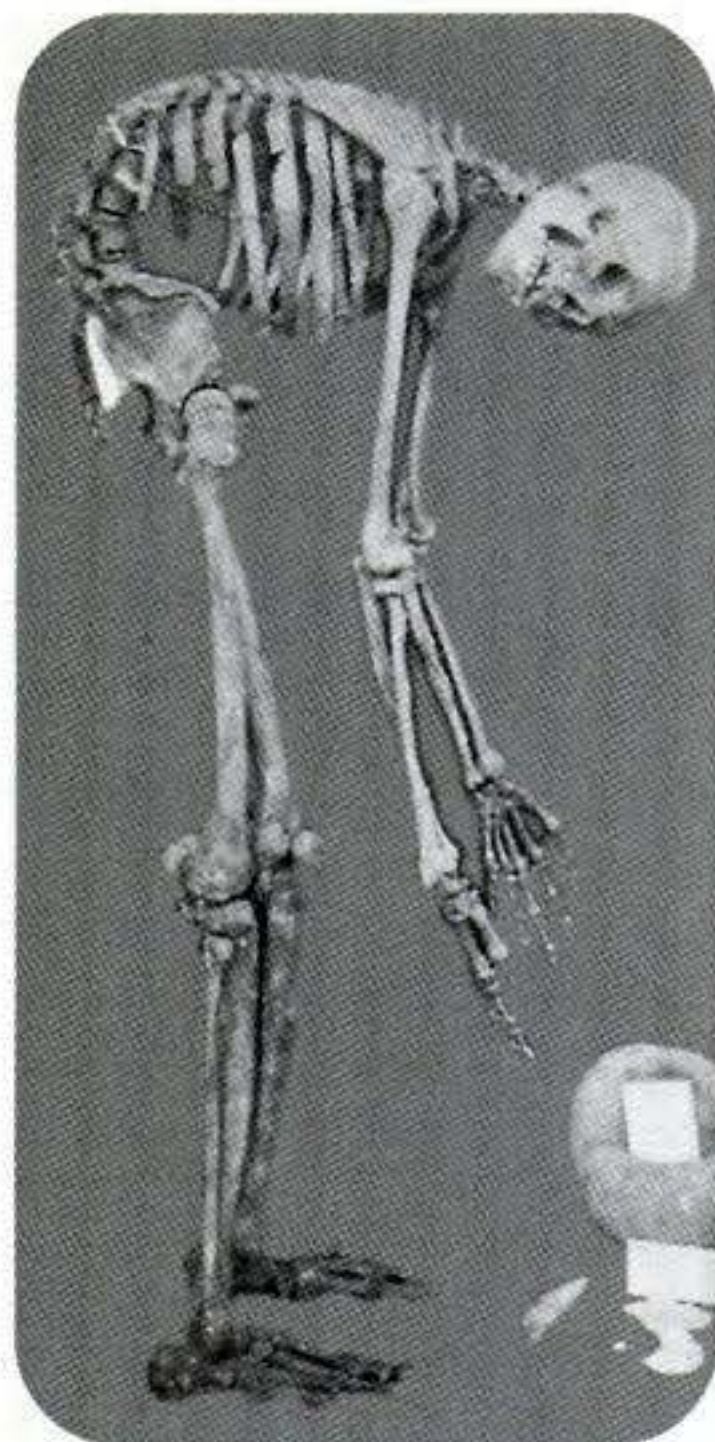
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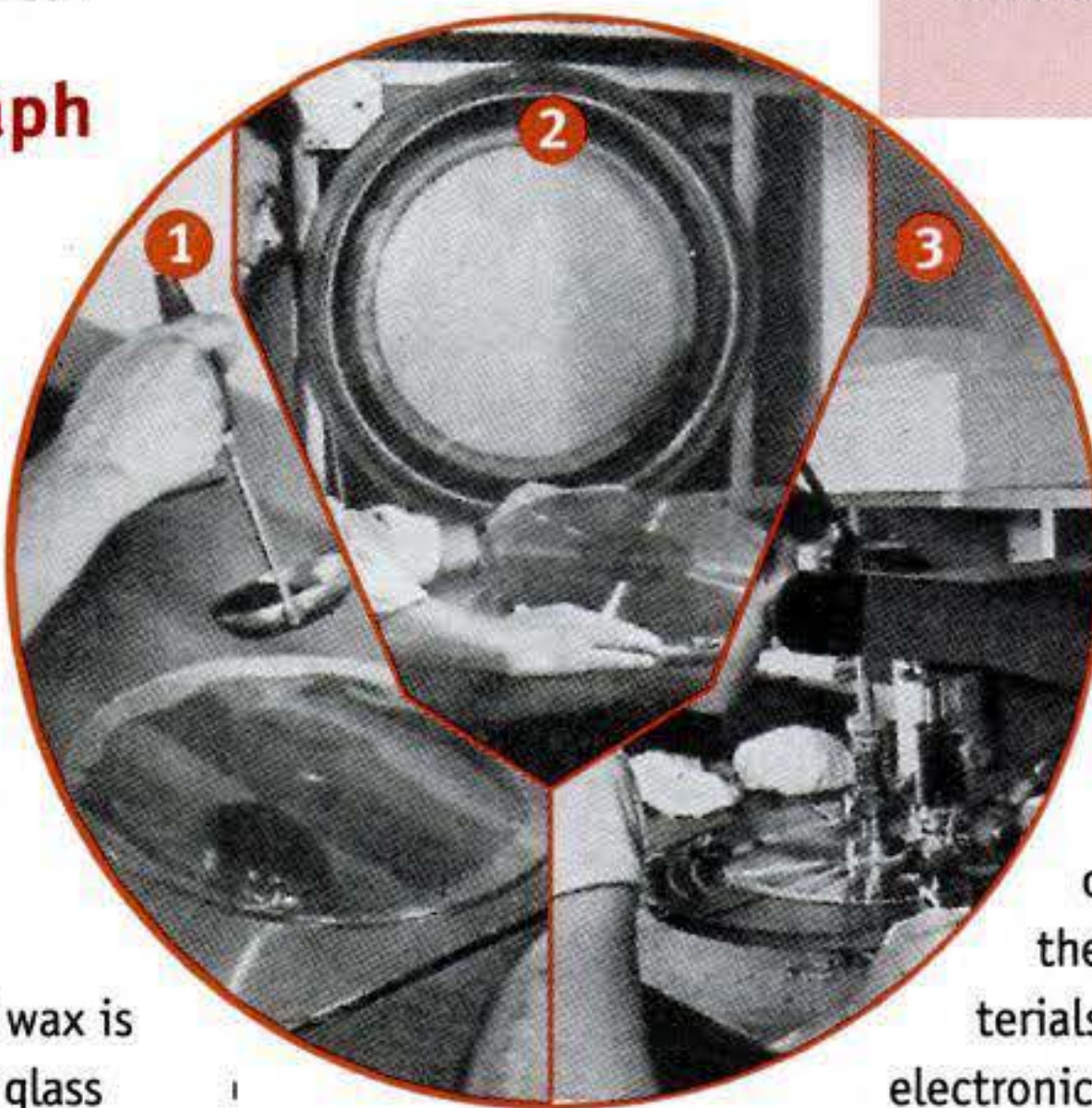


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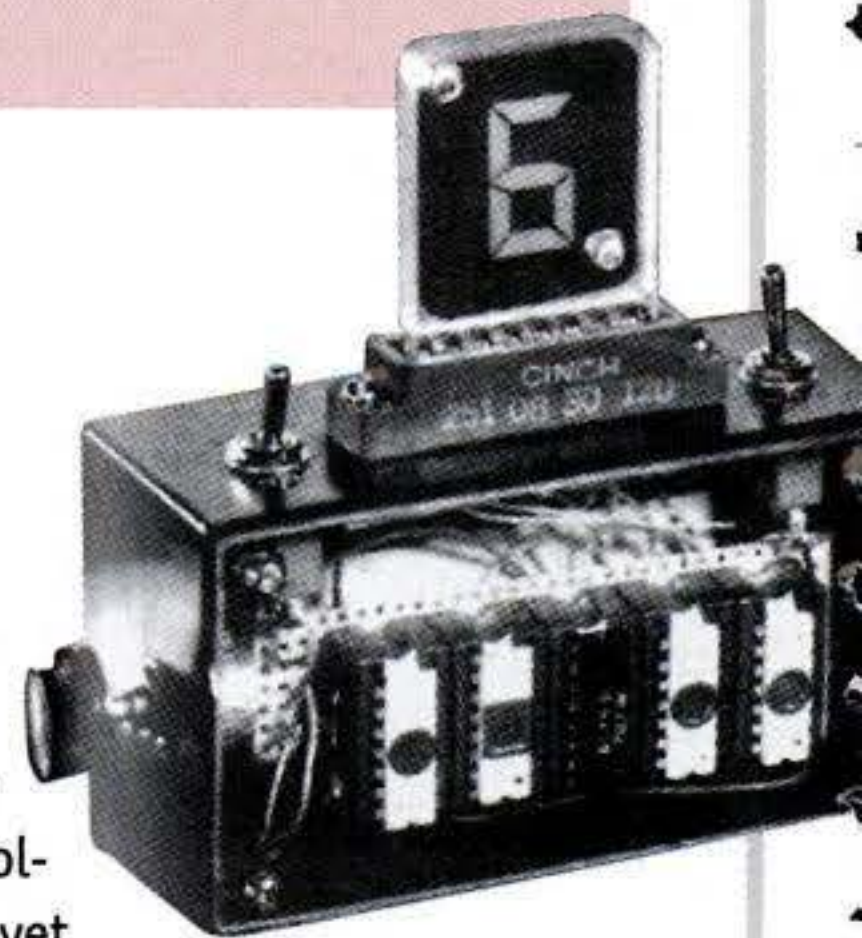
How Phonograph Records Are Made

50 YEARS AGO THE manufacturing of records is tremendously exacting. Fifty percent of the wax-coated glass disks are rejected before reaching the cutting room. Some of the steps are shown here: (1) Liquid wax is poured on a preheated glass plate; (2) the hardened disk is placed in a vacuum chamber to be "sputtered" with an extremely thin coat of 24-carat gold; (3) grooves are centered and a lever punches a hole. —February 1947



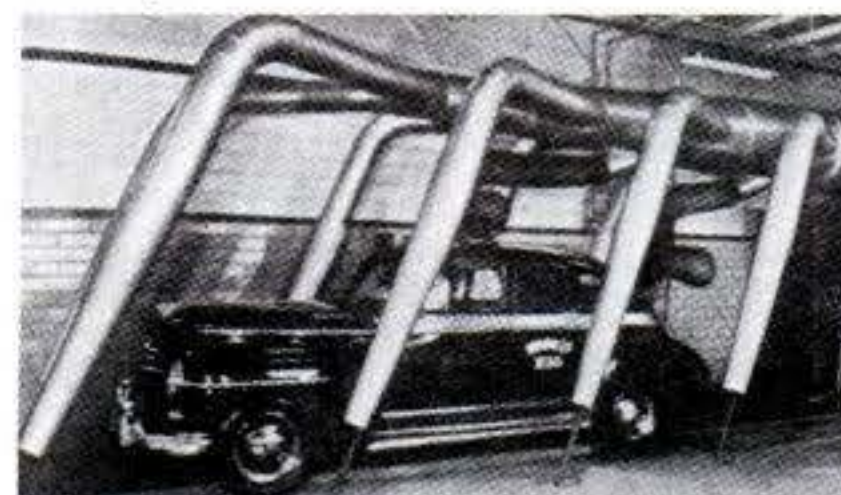
Liquid Crystal Displays

25 YEARS AGO NOW YOU see them, now you don't. LCD digits materialize like visions in a crystal ball. Liquid-crystal substances look like colorless, transparent liquids, yet they can manipulate light waves like solid crystalline materials. This amazing way of displaying numbers has hit the electronics industry like a bombshell.—February 1972



Two-Minute Car Washer

50 YEARS AGO WHEN A CAR EMERGES, SHINY AND clean, from this tunnel of tubes, it has spent no more time in getting a bath than it would in getting its gas tank filled. Air from the pipes evaporates all moisture after the car has passed through a stall (extreme right), where it had a once-over with soft, water-flushed brushes.—February 1947



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